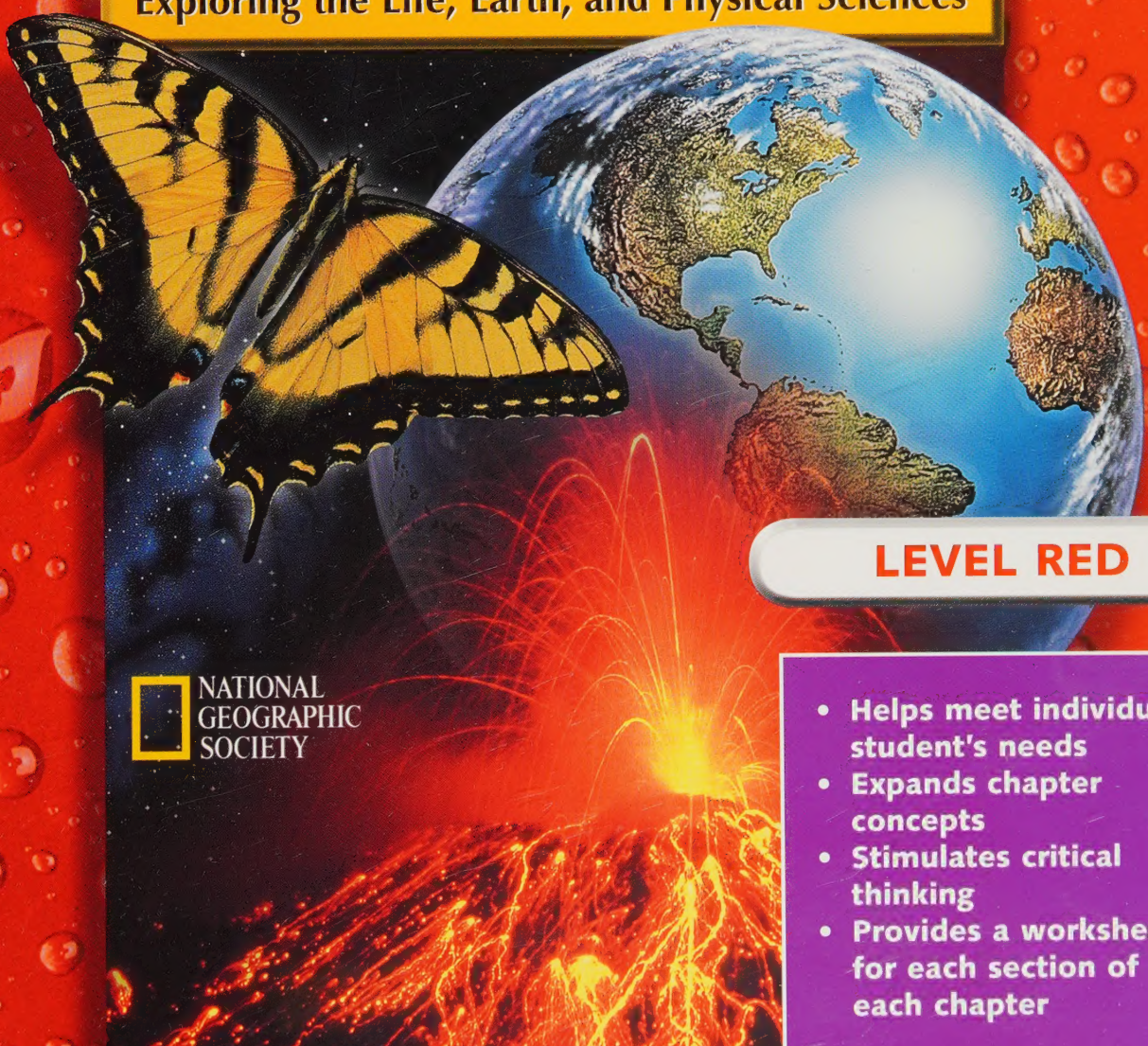
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Exploring the Life, Earth, and Physical Sciences



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TO THE TEACHER

Enrichment worksheets in ***Glencoe Science Voyages*** are designed to provide the above-average student with the opportunity to learn more about information and concepts introduced in each numbered section, or lesson. Each master consists of an article to analyze, a problem to solve, a diagram to analyze, or a simple activity that the student can perform with teacher or parent supervision. Suggested answers appear on reduced pages at the end of the booklet.


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• How Science Works

Archaeology Volunteers

There are many opportunities for volunteers to share in archaeological discoveries. Here are some examples:

Dinosaur Excavation, Montana

Tasks: Volunteers will plot locations of fossils on a topographic map, construct trenches for excavation, excavate fossils using hand tools, and screen-wash sediment to sort fossils.

Maya Ruin, Belize

Tasks: Volunteers will participate in field surveys, making maps, taking photographs, excavating, recording, and cataloging.

Hopi Ruin, Arizona

Tasks: Volunteers will work in both the field and the lab. Field work includes excavating, photographing, mapping Hopi artifact locations, and completing forms. Lab work includes washing, cataloging, sorting, and analyzing ceramics, stone items, and bone and shell tools.

Mammoth Remains, South Dakota

Tasks: Volunteers will use shovels, brushes, and dental tools to excavate bone beds. They will map, record data, and stabilize and preserve bone.

Answer the following questions, using complete sentences.

1. What skills might be useful for a person wishing to volunteer for an archaeological dig?

2. What sciences are used in these archaeological studies?

3. Suppose you could volunteer at one of these sites for two weeks. Which would you choose? Why?

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Chapter 1

ENRICHMENT

Use with Section 2

• Scientific Problem Solving

Inductive Reasoning

When you draw a conclusion based on a number of observations, you are using inductive reasoning. By this process, you make a general statement based on specific examples. The following are examples of inductive reasoning.

Problem to solve:	What percent of the seeds in a package will sprout?
Observations:	In three tests of 100 seeds each, 95, 89, and 92 seeds sprouted.
Conclusion:	About 92% of the seeds in a package will sprout.

Problem to solve:	Which of the two cars in a race is faster—the blue car or the red car?
Observations:	In 5 tests of 10 laps each, with the same driver, the blue car's time was always faster.
Conclusion:	The blue car is the faster car.

The conclusions that result from inductive reasoning only reflect the observations that were used to make them. If other factors would affect the conclusion but were not observed, the process may produce misleading results.

1. Suppose all of the seed tests were done at the same time in the same type of soil and weather conditions. What limitations would that put on the conclusion that 92% of the seeds in a seed package will sprout?

2. What if, unknown to the experimenter, a wheel on the red car was loose? What effect could that fact have on the validity of the conclusion that the blue car is the faster car?

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Chapter 2

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Use with Section 1

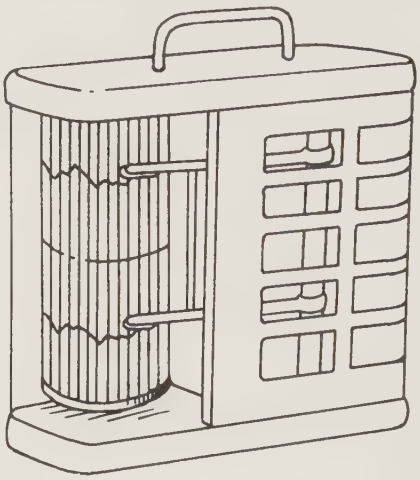
• Description and Measurement

Weather Instrument Precision

The symbol ± is used to show precision in measuring devices. For example, ±3°C means that the actual temperature may be 3°C greater or 3°C less than the temperature shown on the instrument.



Max/Min Thermohygrometer
Digitally displays relative humidity and temperature
Measures relative humidity from 25% to 95% with precision ±5% RH
Measures temperature 0°C to 50°C with precision ±2°C



Battery Operated Hygrothermograph
Measures relative humidity and temperature and records them on a chart
Measures relative humidity from 5% to 99% with ±3% RH precision
Measures temperature from –10°C to 50°C with ±1°C precision

Answer the following questions, using complete sentences.

1. Describe ways these two instruments are alike.

2. Describe the differences between these two instruments.

3. How precise are the measurements for each instrument?

4. If the display on the thermohygrometer shows 15°C, between what temperatures might the actual temperature fall? How do you know?

5. Suppose the thermohygrometer shows 52% relative humidity and at the same time the hygrothermograph shows 55% relative humidity. What would you expect to be the actual relative humidity? Why?

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Chapter 2

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Use with Section 2

• SI Units

Defining the Meter

Over the years, scientists have used different ways to set the exact length of the meter. In 1790 it was suggested that the meter be defined as the length of a pendulum having a period of one second.

In 1791 it was proposed that the meter equal one ten-millionth of the distance at sea level from the north pole to the equator. In 1799 a platinum bar one ten-millionth of the length of the part of the meridian that reached from the north pole through Paris to the equator was created as the prototype for the meter. This bar, the Metre des Archives, was one meter long from end to end at 0°C. In 1889 a meter bar made of platinum and iridium and measured at 0°C became the standard.

In 1960 a definition based on the wavelength of krypton-86 radiation in a vacuum was instituted. The definition changed again in 1983, when the current definition was established. A meter is now defined as the length traveled by light in a vacuum in 1/299 702 458 of a second.

1. What other unit needed to be standardized before the meter could be defined under the 1983 definition?

2. What are some possible problems with using a physical model as a prototype?

3. Why was it necessary to specify a particular meridian when determining the length of a meter?

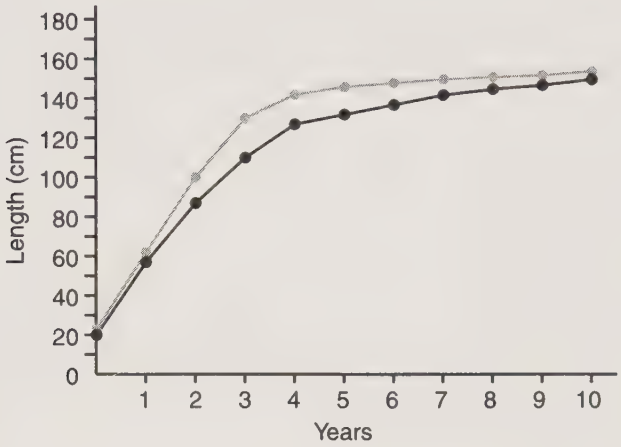
4. How precise is an everyday meterstick compared to the length of the standard meter?

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• Communicating Data

Double Data

The double line graph shows the growth of two alligators. The vertical scale shows the length in centimeters.



1. Is a double line graph appropriate for presenting the alligators' growth? Explain.

2. At what age was the difference in the two alligators' lengths the greatest? Explain how you determined your answer.

3. How can you use the graph to figure out when each alligator grew the most?

4. Write a description comparing the lengths and growth of the two alligators at various ages.

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• Structure of Matter

Flow, Flow, Old Phlogiston!

Before Antoine Lavoisier developed the oxygen theory of burning and rusting, most scientists believed in the phlogiston (floh JIHS tuhn) theory. Each theory is briefly described below.

- **Oxygen Theory.** When wood burns, it combines with the oxygen in the air to form new substances—carbon dioxide, water, and ash. When iron rusts, it combines with the oxygen in the air to form a new substance, iron oxide. In both cases, the total mass of the original substance and the oxygen it combines with equals the total mass of the resulting substances.
- **Phlogiston Theory.** Wood is made up of ash and a substance called phlogiston. When wood burns, it gives off phlogiston into the air, leaving the ash. Iron is made up of metallic ash (now called iron oxide) and phlogiston. When iron rusts, it gives off phlogiston into the air, leaving the metallic ash.

Answer the following questions, using complete sentences.

1. Two experiments that scientists used to test the phlogiston and oxygen theories involved burning wood in a closed container filled with either pure nitrogen or pure oxygen instead of air. (Air consists of 78% nitrogen, 21% oxygen, and 1% other gases.) The wood would not burn in the nitrogen container, but it burned vigorously in the oxygen container. Which theory do these results support? Explain.

2. When iron rusts, the resulting substance has a greater mass than the original iron. Which theory does this result seem to fit better? Explain.

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Chapter 3

ENRICHMENT

Use with Section 2

Elements: The Building Blocks of Matter

The Periodic Table

Use a periodic table to complete the first four columns of the chart below. Then use the Internet or research books, such as a dictionary or encyclopedia, to complete the last column. When you have finished, answer the question below.

Element	Symbol	Number of protons	Atomic mass	Metal, nonmetal, or metalloid	Characteristics and uses of elements
Hydrogen					
Carbon					
Oxygen					
Sodium					
Silicon					
Iron					
Krypton					
Chlorine					
Plutonium					
Lead					
Silver					

Name three things that you can predict about an element just by knowing its position on the periodic table. _____

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• Compounds and Mixtures

Compounding Compounds

Part A

You should already know that the formula for water is H_2O. However, did you realize that hydrogen and oxygen, the two elements in water, are found in thousands of compounds? Use research books such as encyclopedias or dictionaries to complete the columns in the table below.

Common name	Chemical name	Formula	How many atoms of hydrogen? Oxygen?	What other elements are in the compound?	Description/Uses
Wood alcohol					
Ammonia cleaning solution					
Baking soda					
Sugar					
Vinegar					
_____	_____	_____	_____ _____	_____	_____ _____
_____	_____	_____	_____ _____	_____	_____ _____

Part B

Can you think of any other compounds that contain hydrogen and oxygen? Add at least two additional compounds to the table and complete the columns for these compounds.

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Chapter 4

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Use with Section 1

Physical and Chemical Properties

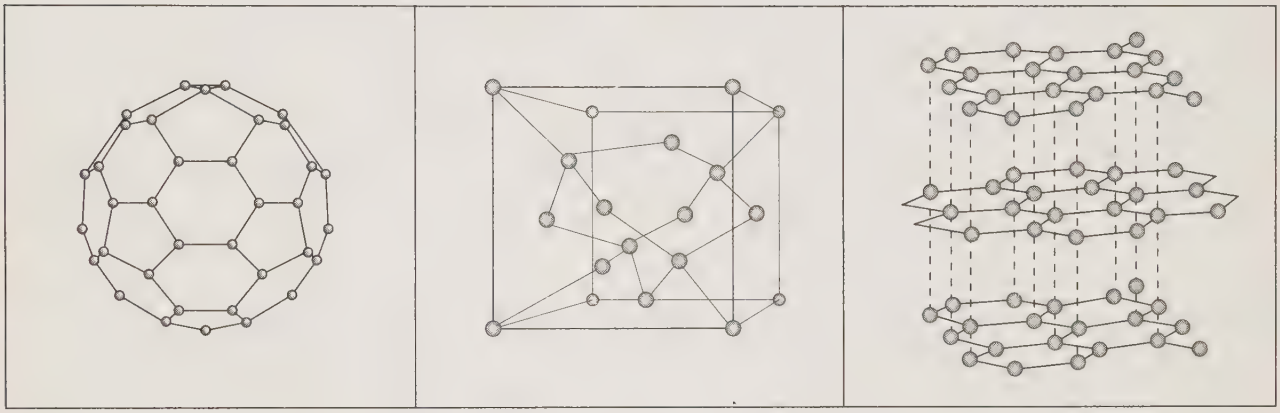
Properties of Carbon

Carbon is one of the most common elements in the world. It forms the tissue of every living creature from an elephant to a spinach leaf. It makes up the products we use to fuel our cars and heat our homes. In one form, it is so soft that it easily rubs off on paper. In another form, it is the hardest natural material known. For years, scientists have explored how the same element can make such very different substances.

One answer is that each carbon atom has four electrons in its outer shell (or orbit). Because the outer shells of most atoms can hold eight electrons, carbon atoms easily form bonds with many other kinds of atoms—including other carbon atoms. However, carbon atoms can bond in several different ways. The drawings below show three different forms of carbon. The circles represent atoms; the lines represent chemical bonds holding the atoms together.

Which properties do you think go with each form of carbon?

Draw a line to the sketch that matches each form. Then on the lines beneath each form of carbon, write the number of the descriptive phrase (from the list below) that fits that form.



Diamond— ____ , ____ , ____ Graphite—____ , ____ , ____ Fullerene—____ , ____ , ____

Which of these descriptive phrases goes with which compound?

1. The hardest natural structure
2. A recently discovered type of carbon, also known as "buckeyballs"
3. A soft type of carbon that rubs off easily on paper
4. Clear crystal
5. Used in pencil lead
6. Conducts heat and electricity
7. Scientists use it as a "cage" to hold other atoms
8. Used to cut glass and steel
9. Added to lubricants

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NAME DATE CLASS

Chapter 4

ENRICHMENT

Use with Section 2

• Physical and Chemical Properties

Things Are Heating Up . . .

Burning a piece of wood causes a chemical change to occur. The matter in the wood changes to produce gases and charcoal. Heat can cause many kinds of chemical changes, but not all changes caused by heat are chemical changes. Often, heat causes a physical change.

Heating or cooling materials can change their state from solid to liquid, liquid to gas, or back again. These changes in the state of matter are physical changes. When water freezes or melts, a physical change has occurred.

Most materials expand when they are heated and contract as they cool. Two exceptions to this rule are water and rubber. These substances expand when they are cooled and contract when they are heated. For example, when water freezes, it expands to fill a larger space than the liquid water did.

Use this information and what you already know about matter to answer the questions below.

1. Why should you never put a full, sealed bottle of water in the freezer?

2. Why are many bridges built with gaps (called expansion joints) in them?

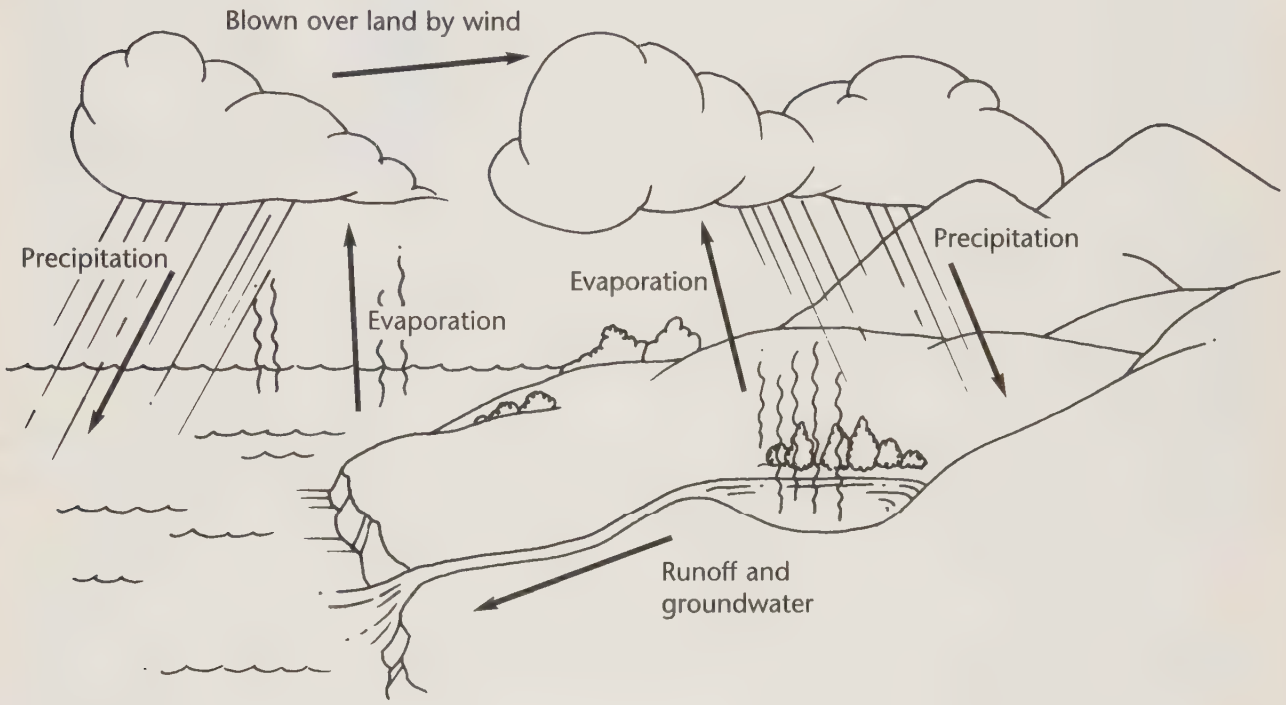
3. Think about it. . . why should you never pour hot liquids into a cold drinking glass?

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• Energy and How It Changes

The Hydrologic Cycle

This model of the hydrologic, or water, cycle shows the circulation of Earth's water. Water evaporates from oceans, inland waters, and vegetation. As the water vapor cools, it condenses to form clouds. Moisture is transported by the clouds and deposited as rain, snow, or hail. Some of the precipitation is absorbed by the ground and becomes groundwater. Some of it returns to rivers, lakes, and oceans as runoff.



Answer the following questions, using complete sentences.

1. Describe the transfer of energy in this system.

2. Is the water in this system conserved? Do you think the total amount of Earth's water remains the same? Explain your thinking.

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Chapter 5

ENRICHMENT

Use with Section 2

• Temperature and Thermal Energy

In the Eye of the Hurricane



Many people have seen or read news reports about hurricanes. To some people, they are fierce displays of how devastating nature can truly be. To others, they are beautiful reminders of the energy found in Earth's environment. Scientists also see hurricanes as intriguing events worthy of great attention and study.

Many forces combine to form a hurricane, including the temperature of ocean water and the collision of winds blowing from the east and west. Even Earth's rotation plays a role. But much of a hurricane's movement is caused by changes in density. Particles in warm air have more energy than particles in cool air, so warm air is less dense than cool air. As a result, warm air rises. Since cool air is denser than warm air, cool air sinks.

In a hurricane, warm air continually moves up from the ocean's surface, and cool air continually moves down from high in the atmosphere. That's because as warm air rises, it cools and becomes more dense. Finally, the cooled air sinks back down. As it does, it becomes warmer and less dense. When it reaches the ocean's surface, the whole cycle begins again. At the same time, Earth's rotation causes the hurricane to move in a whirlpool pattern. In the center, or "eye," of the storm is an area of low pressure. The eye of a hurricane is quite calm, but the area immediately outside it is the most destructive part of any hurricane.

Hurricanes generally originate near the equator and over water. The ones that form in the Atlantic Ocean usually occur just north of the equator. Hurricanes in the Pacific Ocean can form to the north or south of the equator. No matter where they form, these storms are ranked in categories between 1 and 5. Category 1 is the least aggressive, and category 5 is the worst storm possible.

Category	Winds	Storm surge (ocean water pushed ahead of the hurricane by strong winds)
1	74–95 mph	4–5 ft
2	96–110 mph	6–8 ft
3	111–130 mph	9–12 ft
4	131–155 mph	13–18 ft
5	155+ mph	18+ ft

Draw your own hurricane and label these parts:

1. Eye
2. Warm air
3. Cooler air
4. Area of most destruction
5. Area of least destruction (except the eye)

Briefly describe your hurricane. Include its category ranking, wind speeds, storm surge, and name. (There is a rule for naming hurricanes. Can you find out what it is?)

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Chapter 5

ENRICHMENT

Use with Section 3

• Chemical Energy

Enzymes and Nutrition

Enzymes, or biological catalysts, carry out chemical reactions in a much more efficient manner than chemical catalysts. Nearly every chemical process has its own specific enzyme. The human body contains thousands of enzymes to carry out life processes, including digestion, blood clotting, hormone production, and binding of oxygen to red blood cells. One method of increasing the rate of these and other chemical reactions is to increase the temperature. However, this is not practical for the biological systems of humans and other animals. Enzymes can speed up reactions without raising the temperature. How does this process work?

Substance #1 (undigested food, for example) contains a certain amount of energy. It requires additional energy to be transformed into substance #2 (such as chemical energy that the body's cells can use). As #1 proceeds with the transformation, it reaches its highest possible level of energy. At this point it's in the transition state, 1+. The physical structure of one particular digestive enzyme is a perfect match for the transition state 1+. The enzyme binds to the transition state and stabilizes it. After the transition state is formed, 1+ completes its conversion to substance #2.

The difference in energy between the substance and its transition state is called the activation energy. Enzymes reduce the activation energy by stabilizing the transition state. This allows more molecules of the substance to reach the transition state, which can then be converted into the new substance.

Metabolic enzymes are found throughout the body's blood, tissues, and organs. Digestive enzymes are secreted by the stomach, pancreas, small intestine, and other digestive organs. If a person lacks the ability to produce a certain digestive enzyme, she will be unable to convert specific foods into chemical energy that her body can use. The results of this may include malnutrition (not from lack of ingesting food, but from the inability to use it), bloating, and allergies. The production of enzymes is directed by a person's DNA. A genetic "mistake" or an inherited genetic condition may affect enzyme production.

Food enzymes are present in raw foods. They include protease to digest proteins, amylase to digest starch, lipase for fats, and cellulase to digest cellulose. These enzymes help us digest the foods that contain them. Cooking food at temperatures above 54°C, however, will destroy the enzymes. Microwaving food and irradiation can also harm enzymes. This is unavoidable in some situations. Meat and fish must be cooked thoroughly in order to kill disease-causing microbes. In order to digest cooked foods, the body's own enzymes must work extra hard. Nutritionists recommend that people eat a lot of fresh fruits and vegetables, not just for the nutrients, but also for the natural enzymes.

1. How do enzymes increase the efficiency of chemical reactions in the body?

2. What are the three types of enzymes that the body uses and where are they found?

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NAME DATE CLASS

Chapter 6

ENRICHMENT

Use with Section 1

• How does speed change?

The Art of Motion

Think back to the last time you read a comic book or saw a cartoon in the newspaper. Chances are that somewhere in that comic strip, the cartoonist showed a character in motion. Do you remember how it was done? Perhaps the cartoonist inserted horizontal lines to show motion. Maybe the cartoonist altered the actual shape of an object. List two or three techniques for showing motion in cartoons.

1. _____

2. _____

3. _____

Using simple figures, motion lines, or other techniques, draw three cartoon panels of two automobiles on a highway. One is moving at a constant speed and one is accelerating.

What formulas did your cartoon illustrate?

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• Why do things fall?

Mars Pathfinder: Coming in for a landing, and a landing, and a landing . . .

Launching the Mars Pathfinder in December, 1996, was one of the easier parts of that historic mission. The seven month journey to reach Mars progressed without any problems. Landing Pathfinder safely on Martian soil, however, required scientists to use some "low-tech" procedures that you might not associate with a complex space mission—a parachute and air bags.

The force of gravity on Mars is 3.7 m/s^2. Though that is less than one third that of Earth, it still exerts a significant pull on objects that enter its atmosphere. The logical solution to preventing Pathfinder from crashing onto Mars would seem to be a combination of rockets, engines, and braking mechanisms that would control the landing in a manner similar to that used for jet planes. But the scientists who built Pathfinder had a limited budget. All those rockets and engines would have been expensive to build and would have required large amounts of fuel.

So Pathfinder became the first "Martian skydiver." When it entered Mars' atmosphere, 130 km above the surface, it was traveling at 7400 m/s. At just over 9 km above the ground, a parachute opened and Pathfinder's speed gradually decreased to 370 m/s. As it continued to fall/float toward Mars, the lander that contained Pathfinder was lowered from the base of the parachute by a leash. Its speed continued to decrease, slowing to 67 m/s. Ten seconds before it landed, several airbags inflated and formed a protective shield around the lander. The leash was automatically cut 6.2 s later. When Pathfinder finally made contact with Mars, it was traveling at about 12.5 m/s. It landed, bounced about 15 m in the air, and then bounced 15 more times like a beach ball before it finally came to a stop about 1 km away. The entire bouncing sequence took about 2.5 min. The air bags were deflated and rolled up, the lander opened, and Pathfinder emerged.

Scientists still had to use some rockets to control the entry, but the parachute/air bag combination helped reduce the costs of the Pathfinder mission to one-fourteenth that of the Viking missions in 1976.

1. Would the same type (size, number) of parachutes and air bags have allowed Pathfinder to land gently on Earth? Why or why not?

2. A force of 40 N is exerted on each of two objects, one on Mars and one on Earth. What is the mass of each object?

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Chapter 6

ENRICHMENT

Use with Section 3

• How do things move?

Newton and His Forces



Sir Isaac Newton was born on Christmas day in 1642. In that same year, another famous scientist, Galileo, died. Together, Galileo and Newton's scientific ideas changed all of science. They ended traditions that dated back more than a thousand years, to the Greek philosopher Aristotle.

Aristotle believed that the natural state of any object was to be at rest. In addition, he said that an object would constantly work toward reaching that state. Both Galileo and Newton disagreed. Galileo developed idea that any object resisted any change in its motion. He called this phenomenon inertia. Newton went even further, saying that an object's motion would not change unless a force acted on it.

Newton's Three Laws

1. An object at rest will remain at rest, or an object moving in a straight line at constant speed will continue to do so until a force acts on it.
2. An object that has a force acting on it will accelerate in the direction of the force.
3. Forces always occur in equal but opposite pairs.

Apply what you've learned.

1. You are rolling a marble on the carpeting. Every time it comes to a stop you give it another push. Describe how Aristotle, Galileo, and Newton might explain what is happening to the marble as it slows and then stops.

2. You are a passenger in a car on a stormy and windy night. It is difficult to see because of the heavy rain. Suddenly the driver sees a fallen branch on the road and swerves to avoid it, and you are thrown against the car door so hard that it hurts. Later you discover a bruise on your arm. Why were you thrown against the door?

3. A meteor is headed directly from Mars to the sun. It approaches the moon, and slowly but surely its course changes, and it hits the moon's surface.

 a. In what direction was inertia carrying the meteor? _____

 b. What force changed the course of the meteor? _____

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ENRICHMENT

• What is work?

Work, Work, and More Work

Classify the following as positive work (force and motion in the same direction), negative work (force and motion in opposite directions), or no work (no motion, or motion at right angles to the force).

1. carrying a suitcase _____
2. typing _____
3. holding a bag of groceries _____
4. lifting an elevator _____
5. upward part of a jump on a trampoline _____
6. downward part of a jump on a trampoline _____

Designing Your Own Experiment

Use the following materials to create an experiment or experiments that will demonstrate positive work, negative work, and no work at all.

ball(s)	string	book(s)
tape	board	object of your choice

Answer the following questions, using complete sentences.

1. Describe your experiment(s). Include exactly what was done to demonstrate positive work, negative work, and no work.

2. In the space below sketch a picture of your experiment(s). Use arrows to indicate the direction of work.

Bonus Question

Calculate the amount of work done in your experiment(s).

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NAME DATE CLASS

Chapter 7

ENRICHMENT

Use with Section 2

• Simple Machines

Bicycle Gears

The first bicycles did not have multiple gears for ease of riding. Cyclists worked hard to cover ground. They sat over the front wheel because the pedals were attached directly to the wheel's axle. Rotating the pedals once around moved the front wheel only one complete revolution. The invention of the chain drive allowed the rider to sit in a safer, more balanced position between the front and back wheels.

Chain drives transfer the power from the rider's legs, which push down on the pedals attached to levers (the cranks), which turn the axle of the toothed wheel (front sprocket, or chain ring). The chain is a continuous loop attached to the chain ring and a rear sprocket. As the chain ring rotates, it moves the chain, which moves the rear sprocket, which turns the rear wheel's axle. Thus, the invention of the chain drive meant that a rider propelled the bike forward by moving the rear wheel, not the front one. If you think chain drives resemble pulley systems, you're right!

Later, the addition of gears with varying ratios made it easier to ride up steep inclines and pedal more efficiently. Gear ratios are figured by dividing the number of teeth in the front sprocket by the number of teeth in the rear sprocket. If there are 54 teeth in front and 27 in back, the ratio is 2 to 1 because $54 \div 27 = 2$. This means that the rear sprocket goes around twice each time the rider moves the chain ring one complete revolution. If the rear sprocket has 13 teeth, the ratio is about 4 to 1. One turn of the pedals will rotate the back sprocket four times. On downhills or level ground, a rider doesn't have to work as hard to move the bicycle in the "fourth" gear as in the "second."

On the other hand, the steeper the incline, the more difficult it is to ride a bike in a high gear (think of lifting a heavy object straight up instead of pushing it along a ramp). In this case the rider's goal is to easily turn the pedals several times before the rear sprocket completes a revolution. The rider needs to shift into a lower gear.

1. Complete the table below by computing the gear ratios (round to the nearest whole number).
2. Which gear would be best for riding up a steep hill?

Gear	Number of teeth in rear sprocket	Number of teeth in front sprocket	Gear ratio
a	11	60	
b	22	54	
c	41	84	
d	60	54	

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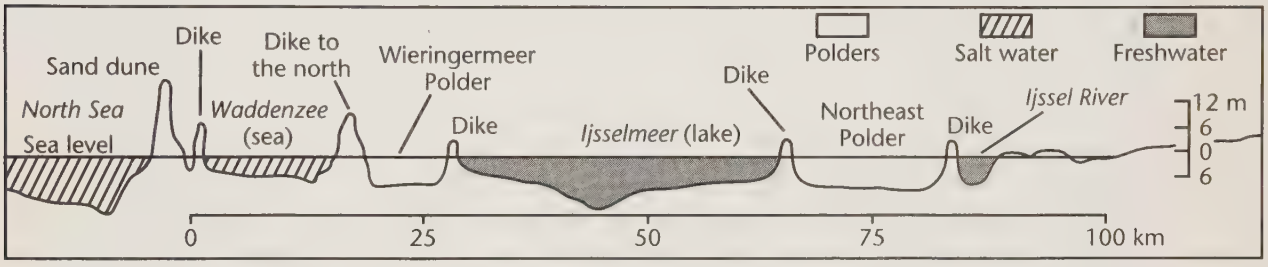
• Landforms

Building New Landforms

People have always changed the land to create more space. San Francisco, New York City, and Boston are examples of places where people have filled in bays with soil to extend their land area. Japan and Hong Kong have built airports in their bays.

One of the best known examples of extending a coastal plain is the Netherlands. Over the centuries, the Dutch have built polders, or tracts of lowland reclaimed from the sea, lakes, or marshes. First dikes of sand and large rocks are built. Then the polder area is pumped dry. In years past, the windmills that dot the Netherlands provided the power needed to pump the sea water out. Now, electrical pumps do the work. The dikes have long been used to keep the sea from flooding the polders and the rest of their land.

The Netherlands occupies a small area of land, and more than 15 million Dutch live there, so the population density is 421 people per square kilometer. (The United States population density is 29 people per square kilometer.) The Dutch need and use every bit of land they have. They even use median strips of highways for crops. In the Netherlands, the largest cities and richest farmland are found on the polders.



Today, the dikes and polders in the Netherlands face several threats. One problem is caused by a seemingly unlikely hazard—muskrats. These rodents tunnel beneath the dikes and can cause a dike to collapse at any time. It takes only a few muskrats to destroy a dike. And the Dutch estimate they have millions of muskrats. With half of their country lying below sea level, the Dutch take the muskrats seriously—they have hundreds of workers whose jobs are to trap the muskrats.

The Dutch also worry that global warming might harm their system of dikes and polders. During a warm winter in 1995, the snow from the Alps melted quickly. This caused the rivers that flow through the Netherlands on their way to the sea to flood. Although the dikes held, about 250 000 people had to leave their homes until the floodwaters receded.

If Earth does grow warmer, more floods will probably occur. After the 1995 flood, the Dutch began a huge project to strengthen the 750 km of dikes. They are also building new kinds of dams. These have sluices, or gates, in them that can be opened or closed as needed. The Dutch hope to direct the floodwaters into open fields rather than toward towns and cities. The Dutch face a huge task, but they have worked for centuries to protect their land. They are confident they will continue to succeed.

Study the diagram that shows a side view of the elevation of the polders. Then answer the questions.

1. From the diagram, what is the approximate elevation of the Wieringermeer and Northeast polders?

2. Along the cross section in the diagram, about how much land is above sea level?

3. Why must the Dutch continue to strengthen the dikes and build new dams?

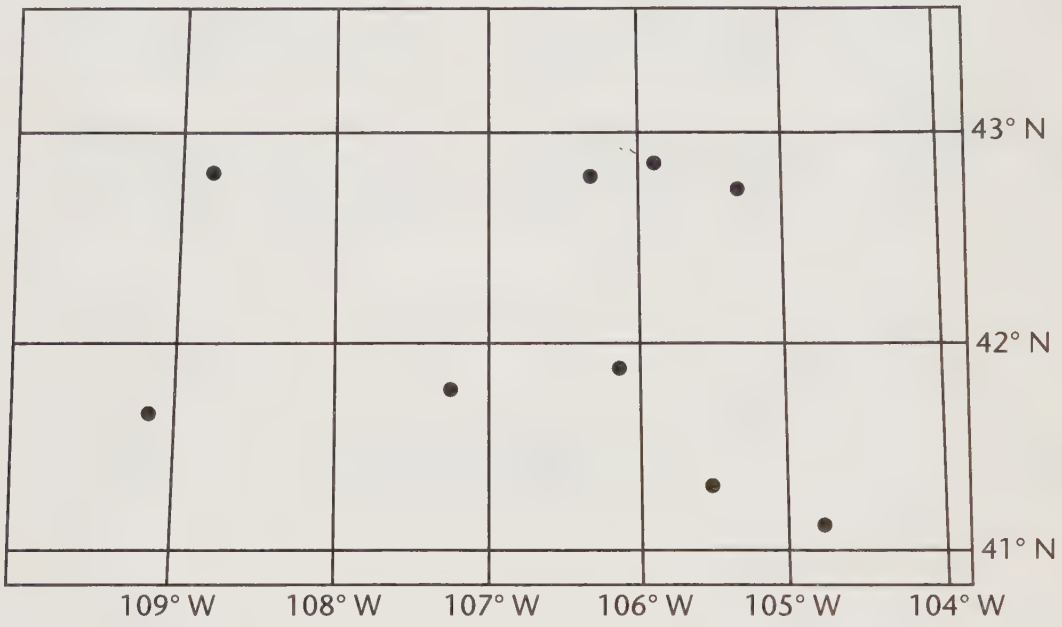
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• Viewpoints

Degrees and Minutes

Each degree of latitude or longitude may be divided into **minutes.** There are 60 minutes in a degree. A minute may be written with the symbol '. For example, a location identified as 30° 30'E is thirty degrees and thirty minutes east of the prime meridian.

Use the map of part of Wyoming to complete the items below.



1. Place the letter of each city next to its location on the map.

City	Location	City	Location
A. Casper	42° 52'N; 106° 20'W	F. Glenrock	42° 53'N; 105° 55'W
B. Cheyenne	41° 9'N; 104° 49'W	G. Rock Springs	41° 40'N; 109° 10'W
C. Laramie	41° 20'N; 105° 30'W	H. Rawlins	41° 50'N; 107° 20'W
D. Douglas	42° 45'N; 105° 20'W	I. Lander	42° 50'N; 108° 49'W
E. Medicine Bow	41° 56'N; 106° 11'W		

2. Which cities would have overlapped if the locations had been rounded to the nearest degree only? _____

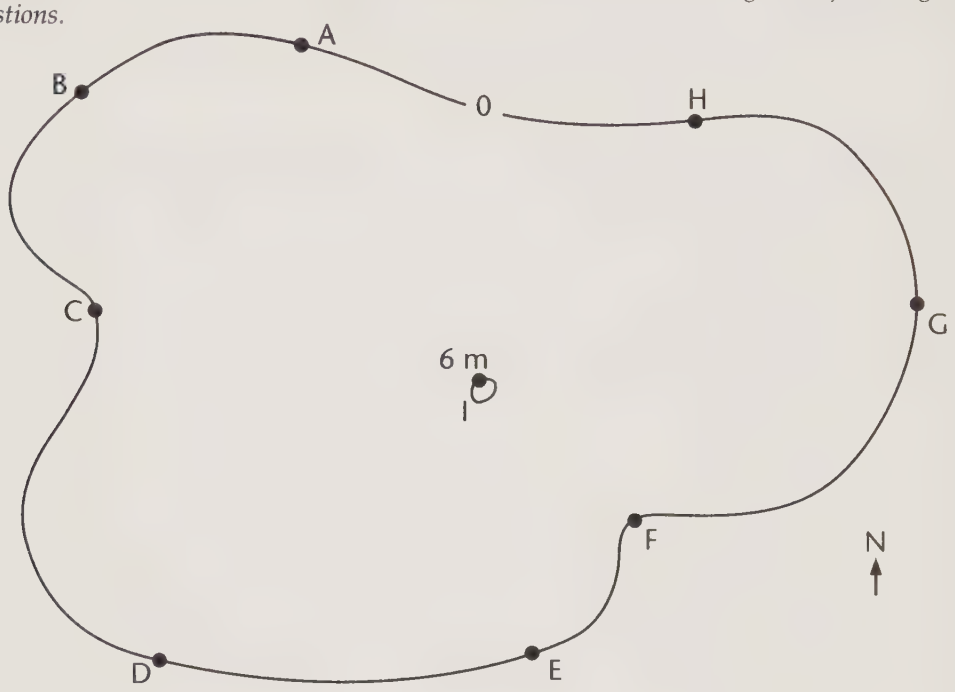
3. The grid of imaginary lines can also be broken down more precisely by using seconds in addition to degrees and minutes. Sixty seconds make up 1 minute. Under what conditions would seconds be needed? _____

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• Maps

Creating a Topographic Map

The map below represents an island off the eastern coast of the United States. The contour lines on the map show sea level and the highest point on the island. Construct additional contour lines according to the following steps, then answer the questions.



A. Divide the distance from point A to point I, the highest point of elevation, into 6 equal distances. One section equals a 1-meter interval. Place a dot at each division.

B. Continue Step A for points B–H.

C. Connect the dots for each contour line, following the shape of the coastline.

1. Between which point on the coast and point I is the slope the most gentle? What evidence supports your conclusion? _____

2. Do you see any evidence that a stream flows from point I to any point along the coast? Explain your answer. _____

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• Minerals

Minerals Commonly Found in the Home

Materials

5 ordinary objects made from minerals
pen or pencil

Procedure

1. Collect five examples of items commonly found in the home that are made from minerals. The following list will provide you with some examples: salt, pencil, sandpaper, talcum powder, jewelry, plaster.
2. List the five items in the table below.
3. Write the name(s) of the minerals each item contains.
4. If you have difficulty finding five items, study the "Uses" column of Appendices M and N of your textbook.

Analyze

Item	Minerals
1.	
2.	
3.	
4.	
5.	

Conclude and Apply

Use your textbook to help answer these questions.

1. What is the name of the most common group of minerals? _____

 Do you have any examples of this group? What are they? _____

2. What mineral group contains limestone, dolomite, and marble? _____

 Do you have any examples of this group? What are they? _____

3. What is the most common carbonate mineral? _____

 Do you have an example of this mineral? What is it? _____

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• Mineral Identification

Halides

Use the table below to help answer Questions 1–4.

The **halides** form a small group of minerals. Minerals in this group differ in many ways from each other, but are similar in composition. Halides are soft minerals, and most are water-soluble. The chart shows some properties of the two most common halides.

Characteristic	Halite	Fluorite	Any other halide
Composition	sodium and chlorine	calcium and fluorine	
Location	dried lakes, rock layers	rock layers	
Occurrence	worldwide in dry areas	common vein mineral	
Crystal	cubic	cubic	
Color	colorless or light	most colors	
Hardness	2.5	4.0	
Luster	glassy	glassy	
Other properties	brittle, transparent, sometimes flourescent, water soluble	brittle, transparent, often flourescent	

Less common halides and their composition include:

- sylvite (potassium and chlorine)
- sal ammonica (aluminum and chlorine)
- cerargyrite (silver and chlorine)
- bromyrite (silver and bromine)
- calomel (mercury and chlorine)
- atacamite (copper and chlorine)
- cryolite (sodium, aluminum, and fluorine)

1. Describe similarities in the physical properties of halite and fluorite. _____

2. Most halides are water-soluble. Why do you think minerals that are highly water-soluble are difficult to find in large deposits or are found only in dry regions? _____

3. The halides listed above include sodium, calcium, potassium, aluminum, mercury, silver, or copper in their composition. Tell how these compounds are alike. Then write a definition of halides based on the elements that make up their composition. _____

4. Research a third halide. Add its characteristic to the chart.

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• Uses of Minerals

Gold!

Use information from the paragraphs below and from library references to answer Questions 1–4.

Gold was among the earliest metals discovered. It occurs in octahedral crystals, but is also found as flakes, thin wires, and veins. From the beginning, it was prized for its beauty and its rarity and came to be a sign of wealth. It was used to make coins and bars which, like money today, could be used to buy things.

The ancient Egyptians were among the earliest peoples to develop goldsmithing as an art, making jewelry and other beautiful objects from the metal. They used solid gold, beating and pounding it to the shape they wanted. Gold is easily worked, since it has a hardness of only 2.5.

Early in America, gold was mined for decorative uses. The Inca writer Garcilaso de la Vega, writing in the early 17th century, described the Temple of the Sun at Cusco: "The four walls were hung with plaques of gold, from top to bottom, and a likeness of the Sun topped the high altar. This likeness was made of a gold plaque twice as thick as those that paneled the walls . . . the whole thing was so immense that it occupied the entire back of the temple. . . ."

Gold can be found in most parts of the world, but it often is difficult to separate it from the other minerals, usually quartz, where it is found. Frequently a ton or more of rock will yield only a few dollars' worth of pure gold. Some gold on Earth's surface is found in the slow-flowing parts of rivers. Uncovered by erosion, gold is washed downhill by rapidly moving water and runs into rivers. The gold drops out of the river water because of its heavy weight. This forms piles of gold called placer deposits. It was this visible gold that began the famous gold rushes in the western United States and in Australia. When gold is found in quartz veins, it is separated by crushing ore and obtaining a concentrate to be smelted (melted and separated).

Gold is still used for jewelry and other art objects. Today, however, other metals, such as copper or silver, usually are added to gold to make it harder and more durable. More recent markets for gold include dentistry and electronics. Strangely, most of the gold that is dug out of rocks ends up underground again—in bank vaults where it is stored by governments and investors!

1. How have the hardness and luster of gold made it an important metal? _____

2. Explain how the weight of gold affected the history of some western states. _____

3. Why is gold expensive? _____

4. The Spanish came to America from Europe in the 16th century. Use a history of Mexico or Peru to find out how the presence of gold affected the lives of Native Americans in Mexico or Peru during the 16th and 17th centuries. _____

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Chapter 10

ENRICHMENT

Use with Section 1

• The Rock Cycle

Analyzing Rocks

Materials



paper and pencil
goggles
metric ruler
rock hammer
streak plate
rock samples
hand lens
glass slide
steel file
towel

Procedure

1. On a piece of paper, copy the table heading shown in "Data and Observations." Make your table ten rows long to provide space for recording information about the ten rock samples.
2. Examine the rock samples. Observe characteristics such as minerals present, the size and shape of mineral grains, and the arrangement of grains. Record your observations in the table you make. An example of what you might observe has been done for you in "Data and Observations."
3. Group all the rocks that have a common characteristic. Make at least three categories. In the last column of the table, record the common characteristics on which you based your groupings.
4. Compare your system of classification with those devised by your classmates.
5. Crush bits of the rocks. **CAUTION:** *Wrap rock samples in a towel before hitting them with the hammer. Always wear goggles when using a rock hammer.*
6. Examine the crushed samples with the hand lens. Record any observable characteristics not seen in the larger specimen.

Data and Observations

Sample	Minerals present	Size/Shape of minerals	Arrangement of grains	Other information	Common characteristic
1	Quartz Feldspar Diorite	0.5 cm, rectangular			grain size similar to samples 3 and 7

Analyze and Conclude

1. Was there any characteristic common to all rock samples? _____

2. What feature was most useful in grouping the rocks? _____
3. What feature was least helpful in grouping the rocks? _____
4. Was there a characteristic observed in the crushed rocks that aided or changed your system of grouping? Explain. _____
5. Was your system of grouping different from those of your classmates? Why might different classification systems be devised? _____

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Chapter 10

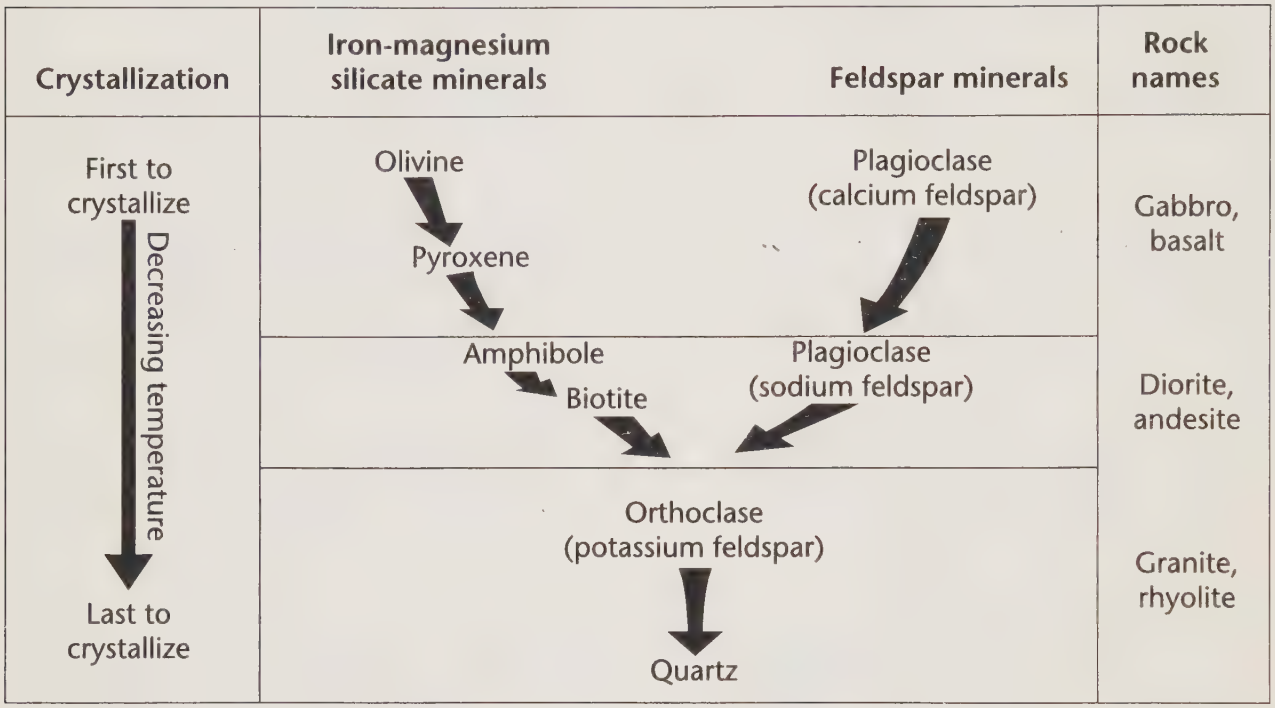
ENRICHMENT

Use with Section 2

• Igneous Rocks

Crystallization

This chart represents the order in which different minerals crystallize from a cooling magma or lava to form igneous rocks. Both mineral names and the rocks they form are shown. Use the chart to answer the questions.



1. Which minerals are the first to crystallize from cooling magma? _____

2. What kind of rocks are formed by these minerals? _____

3. Which mineral crystallizes at the lowest temperature? _____

4. Which mineral, pyroxene or orthoclase, crystallizes from magma first? _____

5. Which feldspar mineral is found in granite? _____

6. What minerals form the rocks diorite and andesite? _____

7. Minerals higher in silica content crystallize from magma at lower temperatures. Which magma, basaltic or granitic, is higher in silica content? _____

8. Magma low in silica content flows more easily. Which kind of lava, basaltic lava or granitic, flows faster? _____

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Chapter 10

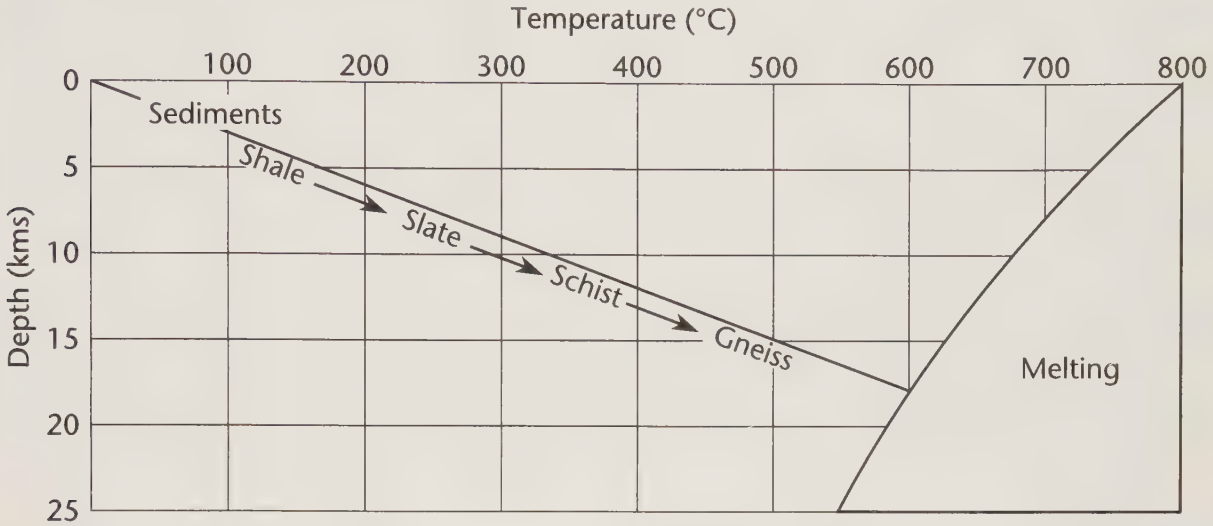
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Use with Section 3

• Metamorphic Rocks

Metamorphic Process

Use the graph to answer questions about the formation of metamorphic rocks.



1. What is the relationship between rock temperature and depth beneath the surface?

2. At a depth of 10 kilometers, what would the temperature be? _____

3. Between 0 and 10 kilometers, how many degrees per kilometer does the temperature increase?

4. Which metamorphic rock shown forms at the highest temperature? _____

5. Through what general temperature range would you expect schist to form? _____

6. How many kilometers beneath the surface does gneiss occur? _____

7. As the depth increases, what happens to the temperature at which rock melts? _____

8. Suppose you knew that a certain metamorphic rock begins to form at about 300°C. How many kilometers beneath the surface might this rock temperature occur? _____

9. How far beneath the surface does shale metamorphose to slate? _____

10. Metasomatism is described as a process by which metamorphic rocks may gradually change into granite (an igneous rock). At which temperature does metasomatism begin? _____

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• Sedimentary Rocks

Analyzing Sedimentary Rocks

Materials 

- flat pan or shallow dish
- spoon
- table salt
- water

Procedure

1. Place about 3 centimeters of water in the pan or shallow dish.
2. Gradually add table salt to the water as you stir it gently.
3. Continue adding salt until no more can be dissolved in the water.
4. Stir the solution thoroughly.
5. Observe and note the appearance of the pan and its contents.
6. Place the pan with its contents on a windowsill or countertop where it will not be disturbed.
7. Once each morning and evening, observe the pan and record what you see.
8. Continue this process until all the water has evaporated.
9. Once all the water has evaporated, observe and record the appearance of the pan.

Analyze

1. What did you observe in the pan as the days passed and on the final day of this activity?

2. What caused the salt deposition in the pan? _____

Conclude and Apply

3. How does what you observed in the pan help explain sedimentary rock formation? _____

4. Sedimentary rocks formed by deposition of minerals when water evaporates are called evaporites. Name a common evaporite mineral or rock. _____

5. Deposition of evaporite sedimentary rocks occurred in the Dead Sea flats and the Bonneville salt flats. Explain what might have happened to cause the evaporite deposits. _____

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Chapter 11

ENRICHMENT

Use with Section 1

• Energy Resources

The Greenhouse Effect and Global Warming

Did you ever get into a car that had its windows closed on a sunny day? You probably jumped out quickly because the inside of the car and the car's interior was very hot. As sunlight passed through the windows, the car's interior absorbed and radiated heat energy. This process is called the greenhouse effect.

The greenhouse effect also happens in Earth's atmosphere. Gases called greenhouse gases—which include carbon dioxide, methane, and nitrous oxide—are found in the atmosphere. These gases naturally absorb heat energy from the sun. This absorbed heat warms the atmosphere, the oceans, and the land. However, increasing amounts of greenhouse gases are being produced, particularly by the burning of fossil fuels. This increase has made the atmosphere absorb more and more radiation.

Scientists are concerned that these increased concentrations of greenhouse gases could cause atmospheric temperatures to rise worldwide. This is known as global warming.

A rapid global warming trend could have devastating effects on the environment. Rainfall patterns could change, affecting the types and amount of plant life in many areas. Global warming could make present farmlands too dry to grow crops. An increase in atmospheric temperature of only a few degrees could cause polar ice caps to melt and sea level to rise, resulting in flooding in many coastal areas.

Answer the following questions, using complete sentences.

1. The absorption of energy from the sun by greenhouse gases is necessary for life on Earth. Without it the average yearly temperature of Earth's surface would be about –25°C! So why are scientists concerned about greenhouse gases?

2. Unlike many pollutants, which affect small regions, global warming affects people worldwide. How do you think the world should approach this problem?

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Chapter 11

ENRICHMENT

Use with Section 2

• Alternative Energy Resources

Tidal Power

Tidal power is a source of energy that could play an important role in generating electric power during the coming years. Tides are the rhythmic rise and fall of the ocean's surface caused by the gravitational pull on the water by the moon and, to a lesser extent, the sun. This back and forth flow of ocean waters can provide a source of energy that does not pollute and will never run out.

Tidal energy can be used wherever there are high tides in a bay that is narrow enough to be enclosed by a dam. During high tide, the bay fills with water. During low tide, the level of the ocean drops below the level of the water stored behind the dam. The stored water is then released. As the water falls, it drives turbines that generate electricity.

The first and largest tidal power plant in the world began to operate in France in 1966. A dam equipped with reversible turbines permits the tidal flow to work in both directions—from the sea to the tidal basin on the incoming tide and from the basin to the sea on the outgoing tide. Russia also has several tidal power plants.

Some disadvantages to tidal power plants include their expense to build and maintain. Also, tidal power plants are not always able to provide energy when it is needed. The amount of energy generated varies according to time of day and with the seasons.

1. List some advantages to using tidal power.

2. List some disadvantages to using tidal power in addition to those mentioned above.

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• Water

The Effect of Pollution on the Life Cycle of a Lake



Runoff from sewage, industrial waste, and fertilizers drains into the lake. The lake becomes clogged by an overgrowth of plants and algae. Fish die from lack of oxygen.

Lakes and ponds go through definite life cycles. When a lake first forms, it contains pure freshwater and little life. Plants and animals begin to live in the lake as it grows older. The organic matter from the plants and animals provides nutrients for other life to grow. A healthy lake has a balance of nutrients and organisms.

Throughout its life cycle, a lake naturally becomes smaller as sediments and decayed plants fill its bottom. Plants grow in from the edges, eventually filling the lake. After a length of time—ranging from a few decades to several thousands of years—the lake disappears.

However, this process is greatly accelerated by runoff containing sewage, industrial waste, and fertilizers feeding into a lake. The lake becomes clogged by plants and algae that feed on the nutrients in these pollutants. When the plants and algae die, bacteria in the lake use oxygen to break them down. The more plants that grow, the more that die, resulting in more bacteria and less oxygen. Fish and other organisms eventually die from this lack of oxygen. The lake dies due to the effects of the pollution.

1. How are lakes affected by pollution?

2. If lakes are already going to disappear when their life cycle is complete anyway, why is pollution such a problem?

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• Land

Saving the Wetlands

A wetland is an area that is covered with shallow water or that has wet soils. Wetlands include swamps, marshes, fens, and bogs. Wetlands are home to a variety of plant and animal life and exist throughout the world.

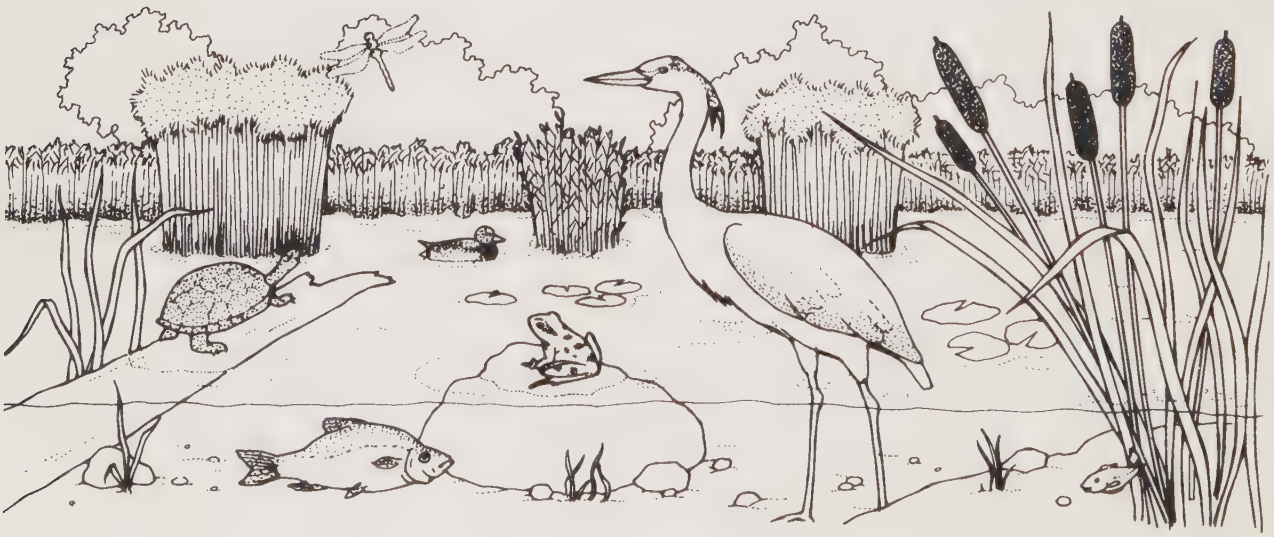
For many years, people thought that wetlands were useless. For this reason, more than 35 percent of the wetlands in the United States had been drained and destroyed by the 1970s. Wetlands were drained or filled in to make way for houses, shopping malls, and other developments. However, since the early 1970s, there has been an increasing awareness of the ecological value of wetlands.

Wetlands help to minimize flooding because they absorb excess water and release it slowly, making flooding less likely. In addition, wetlands store large amounts of water for long periods.

Wetlands also provide rich environments for wildlife. Mammals such as moose, muskrats, and mink find food and shelter in the wetlands. Numerous varieties of birds make their homes there as well. Coastal wetlands are the breeding grounds for many species of fish and crustaceans. Many states have enacted laws to protect wetlands.

1. What are the two main purposes of wetlands?

2. How do you think our environment would be different if our ancestors had not destroyed so many of the wetlands in the past?



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• Earth's Atmosphere

Observing the Effects of Air Pressure

The activity at the beginning of the chapter showed how temperature affects the density of air. When the air in a can became heated by boiling water, it expanded and much of it escaped out of the can before the top was put on. As the air that was left inside cooled, it became denser and took up less space. Because the air pressure on the outside of the can was higher than the pressure inside the can, the sides of the can collapsed. You could see what a powerful force air pressure can be. Here's another experiment about the power of air pressure.

Materials 

glass bottle
sheet of paper
long match or paper drinking straw and match
hard-boiled egg, peeled

Procedure

1. Be sure that the opening at the top of the glass bottle is slightly smaller than the diameter of the egg.
2. Crumple the sheet of paper into a ball and drop it into the bottle.
3. Light the end of the paper drinking straw or the long match. Put the paper, burning end first, in the bottle. Be careful!
4. Let the paper burn until the flame burns out.
5. Set the peeled hard-boiled egg over the opening at the top of the bottle with the pointed end of the egg down.

Analyze

1. What happened to the egg? _____
2. What caused the egg to do this? _____

Conclude and Apply

3. How can you get the egg out? _____

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Chapter 12

ENRICHMENT

Use with Section 2

• Energy from the Sun

Determining Temperature Change

Do the activity below to observe the different ways heat energy can be transfered.

Materials



dark-colored, small block of wood
thermometer
water
electric teapot or teapot and hot plate
coffee mug
ice cubes
room heater or register
clock or watch

Procedure

1. Place a wooden block in direct sunlight and record its temperature.
2. Measure and record the temperature of the block after two hours in the sun.
3. Heat water in the teapot and pour it into the mug. Record the temperature of the water.
4. Place two ice cubes in the water. After 10 minutes, measure and record the temperature of the water.
5. Record the temperature of the air as shown on the thermostat.
6. Ask an adult to turn up the thermostat.
7. Stand near the room heater or register, then stand near the cold air return. Record your observations.
8. After 20 minutes, again record the temperature shown on the thermostat.

Analyze and Conclude

1. What happened to the wood block? _____

2. What type of heat transfer caused what you noticed? _____

3. What happened to the temperature of the water when ice cubes were added? _____

4. Explain the method of heat transfer demonstrated by the ice in the water. _____

5. Explain what happened in the room when the thermostat was turned up. _____

6. Which method of heat transfer is demonstrated by the heating of the room? _____

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• Movement of Air

Thermals

Convection is responsible not only for major wind systems that affect the entire Earth but also for small-scale air movements that affect only a small part of Earth's surface. Land and sea breezes are an example of small-scale air movements, or local winds. These small-scale movements are the result of differences in temperature over land and sea.

Thermals are another type of small-scale movement. Thermals develop only over a few hundred square meters of land and last less than an hour. The formation of thermals is described in the following pictures.



FIGURE 1

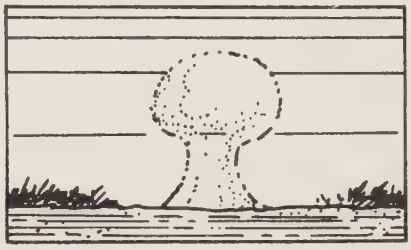


FIGURE 2

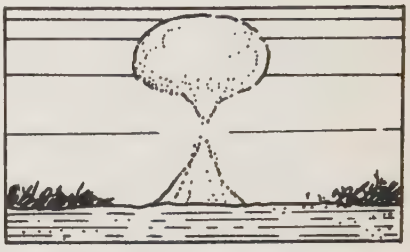


FIGURE 3

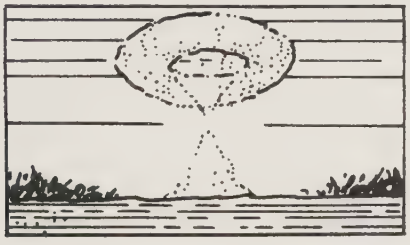


FIGURE 4

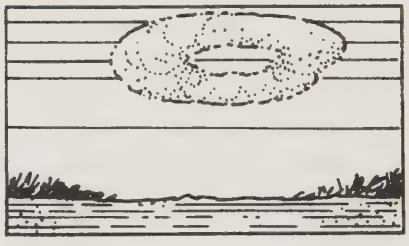


FIGURE 5

Figure 1 shows the thermal beginning as a rising column of air at Earth's surface. In Figure 2, a cap develops at the top. Eventually, the cap breaks off and increases in size as it continues to be forced up (Figures 3 and 4). At higher altitudes, the thermal develops a "donut-shape" before it dissipates in the cooler air (Figure 5).

Thermals may develop where Earth's surface is warm and the overlying air is cool. This may occur anywhere on Earth. The amount of heating at the surface varies, depending upon the amount of solar radiation absorbed by that part of Earth's surface.

1. Thermals occur as a result of hot and cold air movements: _____ air rises and _____ air sinks.

2. What eventually causes a thermal to dissipate? _____

3. Vultures and hawks sometimes "glide the thermals." What do you think this means? Why do you think they do it? _____

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• What is weather?

Relating Clouds to Weather

Clues to predicting the weather can include observations of cloud types.

Materials

camera **CAUTION:** *Do not aim the camera directly at the sun. Damage could occur to the eyes if direct sunlight is observed.*
roll of film
pencil and paper

Procedure

1. Take photographs of the sky during the day for seven days.
2. Record the weather conditions and time of day when each photograph is taken.
3. Watch or listen to a nightly weather report and briefly record what conditions existed that day.
4. Make a table of your data.
5. Use your textbook, cloud charts, and weather forecasts to identify the type or types of clouds in each photograph.
6. Look up the weather conditions that each cloud type in your photographs should have associated with it. Compare this information with your observations.

Analyze

1. List the types of clouds you observed and the weather conditions you noted that were associated with each type. Not all types may have been observed. _____

2. Write a description of each cloud type you observed. _____

3. Do you notice any pattern to the clouds observed and the weather experienced? Explain.

Conclude and Apply

4. What occurs when a stratus cloud forms close to the ground? _____

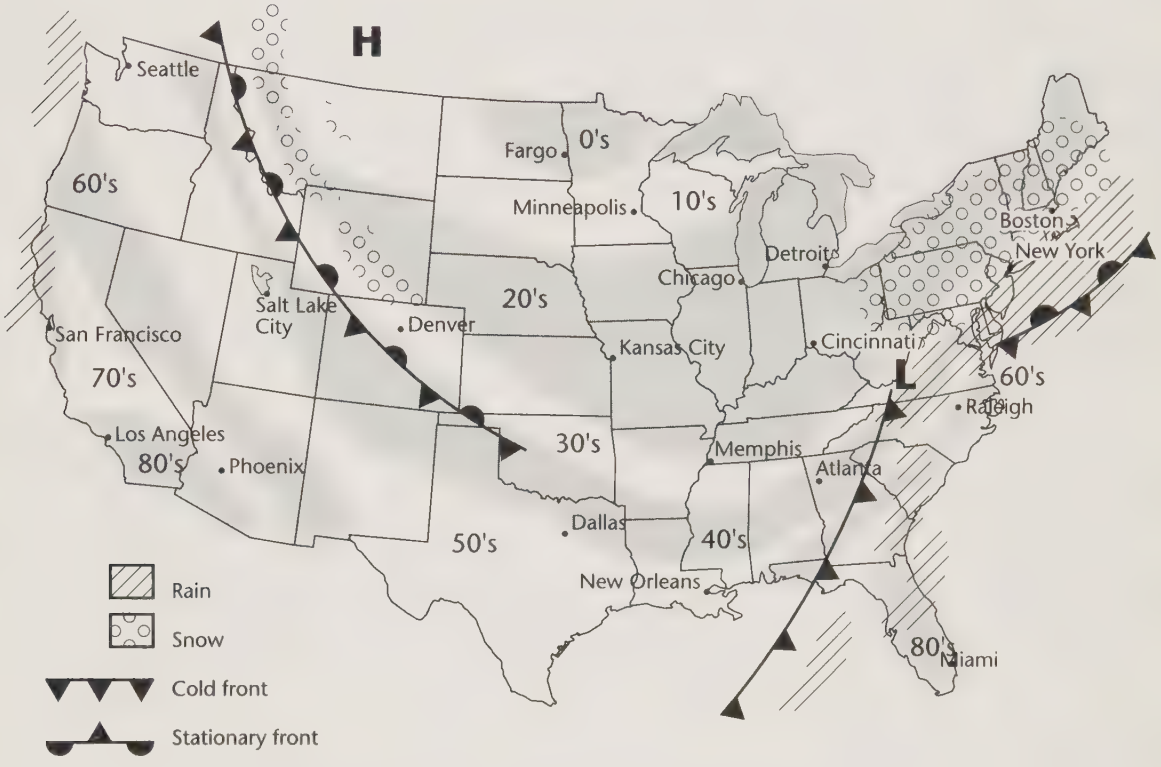
5. Did you observe fog? What were the temperature and moisture conditions?

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• Weather Patterns

Reading Weather Maps

The symbols on the weather map below show the locations of fronts, high- and low-pressure areas, and different kinds of precipitation across the United States at 2:00 in the afternoon on a particular day in March. Shaded bands on the map indicate areas that have about the same temperature. The key below the map tells what the symbols mean.



Answer the questions below based on information in the weather map.

1. Would you expect to find clear weather or clouds near Fargo, North Dakota? _____

2. Where would you expect to find a storm? _____

3. How is the weather in Salt Lake City, west of the stationary front, different from the weather in Denver, east of the front? _____

4. What is happening to the air masses at the cold front? _____

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• Forecasting Weather

Making Forecasts

Materials

Celsius thermometer
magnetic compass
aneroid barometer

Procedure

1. Make a chart like the one shown below to record your weather observations each day for 7 days. Be sure to make observations at the same time and place each day.
2. Determine the temperature by placing the thermometer in a shaded location.
3. Determine the air pressure using the aneroid barometer.
4. Estimate the amount of sky covered by clouds as clear, overcast, or somewhere in between.
5. Determine the types of clouds using Field Guide to Clouds in your textbook.
6. Use a compass to determine the direction from which the wind is blowing.
7. Describe the precipitation. Use the terms *rain, snow, sleet, hail, fog,* or *clear.*
8. Use the data you collect each day to forecast weather conditions for the following day. Note any trends you see in your observations, such as high cirrus clouds preceding rainy weather.

Date	Temperature (°C)	Atmospheric pressure	% Cloud cover	Cloud types	Wind direction	Precipitation	Forecast

Conclude and Apply

1. Was there a relationship between low barometric pressure and the presence of clouds and precipitation? Explain. _____

2. How accurate were your forecasts for the next day? Give an explanation for any errors that may have occurred in your forecasting. _____

3. What weather observations can you make yourself? _____

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Chapter 14

ENRICHMENT

Use with Section 1

• What is climate?

Compare the Climate

You know that latitude is one of the most important factors that affects climate. The tropical climate in places near the equator is very different from the temperate climate of the United States.

Most places near the equator have about the same weather all year. Warm, moist air masses bring hot weather, high humidity, and daily rains to these tropical areas. Temperatures hardly vary from the average of 26°C. Annual rainfall is usually at least 150 centimeters. A great variety of trees grow in the wet conditions of the tropical rain forests. Many grow as tall as 60 meters and form a dense canopy. The ground is dark and shady with little undergrowth. Dense impenetrable jungle with thick undergrowth is found only along riverbanks and other places where the sun reaches. Vast areas of rain forests have been cleared for timber, agriculture, and mining.

The temperate climate is typical of many parts of the United States. It includes a wider variety of conditions than the tropical climate does. The weather can change every day as winds carry a series of low-pressure and high-pressure systems through an area. Generally, low-pressure systems bring wet weather, and high-pressure systems bring clear weather. Temperate climates have winters one to five months long in which plants are dormant. Winter temperatures are below 6°C, the temperature needed for plants to grow. Temperate regions cover only 7 percent of the world's land, but more than 40 percent of Earth's people live in them.

In each space below, identify which climate is being described. Explain your answer using the information provided above.

1. It rains hard here every afternoon. _____

2. There are no leaves on the trees and the plants in the garden look dead. _____

3. If you don't like the weather, wait a day or two and it will change. _____

4. There is a greater variety of plants growing here naturally than anywhere else. _____

5. This climate is always the same. _____

6. High- and low-pressure systems follow each other throughout the year. _____

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Chapter 14

ENRICHMENT

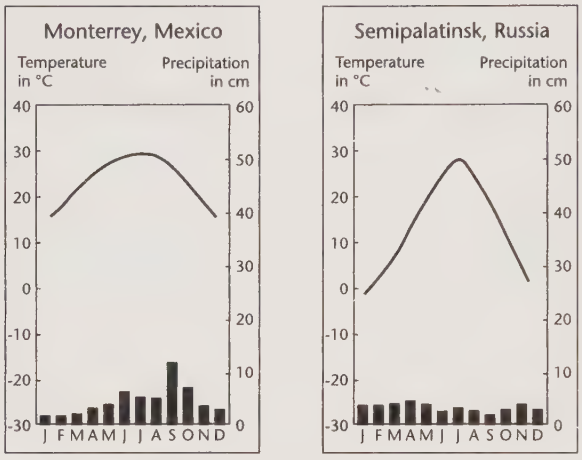
Use with Section 2

• Climate Types

The Steppe Climate

The steppe or semiarid climate zone is located in prairies and grasslands. Steppes are often found surrounding desert areas. Annual rainfall is light, somewhere between the desert and more humid climates. Specific characteristics of steppes depend on their latitude and whether they are located near mountains and oceans.

The graphs below show one way to summarize basic climate information. The line shows how the temperature changes over the year. The bar graphs show the monthly precipitation (J is for January, F is for February, and so on.). Both places graphed are classified as steppes.



Use the information in the graphs to answer the questions.

1. How is the rainfall distribution different between the two places? _____

2. What does the graph tell you about the temperature range in Monterrey? _____

3. What does the graph tell you about the temperature range in Semipalatinsk? _____

4. Compare the climates in the two places. _____

Use the information below to answer the questions about climate in Pueblo, Colorado.

Rainfall: January 1 cm, February 2 cm, March 2.5 cm, April 4 cm, May 4 cm, June 3.5 cm, July 5 cm, August 4.5 cm, September 3 cm, October 2 cm, November 1 cm, December 1.5 cm
Temperature in degrees Celsius: January 0°, February 0°, March 5°, April 10°, May 15°, June 20°, July 24°, August 24°, September 18°, October 11°, November 5°, December 0°

5. When is the rainy season in Pueblo, Colorado? _____

6. Compare the climate in Pueblo to the climate in Monterrey. _____

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ENRICHMENT

• Climatic Changes

Climate and Extinction

About 65 million years ago, at the end of the Cretaceous period, dinosaurs became extinct. But they were not the only species to become extinct at that time. Up to 70 percent of all the species alive disappeared. Because so many different kinds of organisms died out, scientists do not think the cause was specific to dinosaurs, such as a disease. They think there was a general change in the environment. Climate, especially temperature, is an important influence on species' existence.

During the Age of Dinosaurs, from 240 million to 65 million years ago, Earth's climate was generally mild. Glaciers melted and ocean temperatures rose. Mountain ranges in North America and Europe eroded. A warm, shallow sea covered much of the interior of western and southern North America. A warm, shallow ocean flowed around Earth near the equator, and its currents warmed the land. The continents were closer together and nearer to the equator than they are now.

The climate of the continents began to change as they drifted apart. By the end of the Age of Dinosaurs, the level of the oceans began to drop and the seas drained away from the land. Temperatures in the ocean went down. Many species died out when the temperature fell. Almost all the reptiles that lived in the ocean died out at this time. So did 90 percent of the plankton, tiny floating organisms that make up an important source of food to many sea animals. Many shelled sea creatures disappeared as the shrinking ocean reduced their shallow-water habitat.

Large amounts of volcanic activity also took place in the Age of Dinosaurs. Volcanic ash and dust in the atmosphere from this activity may have lowered Earth's temperature by blocking sunlight. It may have also affected Earth's climate by changing the composition of the atmosphere. This change may have increased the amount of solar radiation the atmosphere absorbed. This could have heated the atmosphere, creating a thermal imbalance and unstable weather conditions. The resulting change in Earth's environment could have affected organisms living at that time.

1. What was the climate like during the Age of Dinosaurs? _____

2. How did the climate change from the beginning of the Age of Dinosaurs to the end? _____

3. What are some factors that affected the climate during the Age of Dinosaurs? _____

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• Cells: The Units of Life

Using the Microscope

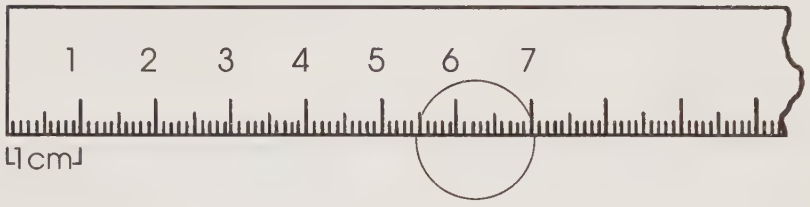
Use the information below to complete the table and answer the questions.

There are many different kinds of microscopes. A magnifying glass is a simple microscope. The term *microscope* commonly refers to a compound microscope. These microscopes are called compound because they are made of several glass lenses in a tube.

The total magnifying power of a microscope is the product of the magnifying power of the lens in the eyepiece and the magnifying power of the lens in the objective. Most compound microscopes can magnify a specimen up to 1000 times its real size.

Microscopes allow you to see fine details. Spaces between objects that are closer together than 0.1 mm can be seen. The ability of a microscope to separate very small distances is called resolving power. If the resolving power of the lens is not good, the image will appear blurred.

When you look into the eyepiece of a microscope, the circular area you see is the field of view. When a ruler is placed across the opening on the stage, the field of view can be measured in millimeters.



	Eyepiece lens	Objective lens		Total	
		Low	High	Low	High
Microscope 1	10×	5X	40X		400X
Microscope 2	8×	10X	60X		
Microscope 3		10X		50X	300X

1. What is the purpose of a microscope? _____

2. How do you find the total magnifying power of a microscope? _____

3. What would cause an image to appear blurred? _____

4. What is the width of the field of view shown above? In centimeters? _____ In millimeters? _____

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• Cell Organization

Building a Cell

Make a three-dimensional model of a cell using the following guidelines.

Materials 

glass cake pan or bowl
light-colored gelatin
various small items to make cell parts (may be food or nonfood items)

Procedure

1. Decide what items you will use to represent each of the cell parts listed below. Refer to the diagram of a cell in your textbook for ideas for the shapes and sizes of cell parts.
2. Prepare enough gelatin to fill your glass container about half to 3/4 full. Follow the instructions on the gelatin package.
3. When the gelatin becomes thick enough, add your cell part items to the gelatin.
4. Refrigerate your cell to finish setting.
5. Once you have built your cell, organize your information in the table below.

Data and Observations

Cell part	Item used	Function of actual cell part
cell membrane		
nucleus		
chromatin		
endoplasmic reticulum		
ribosomes		
mitochondria		
Golgi bodies		
vacuoles		

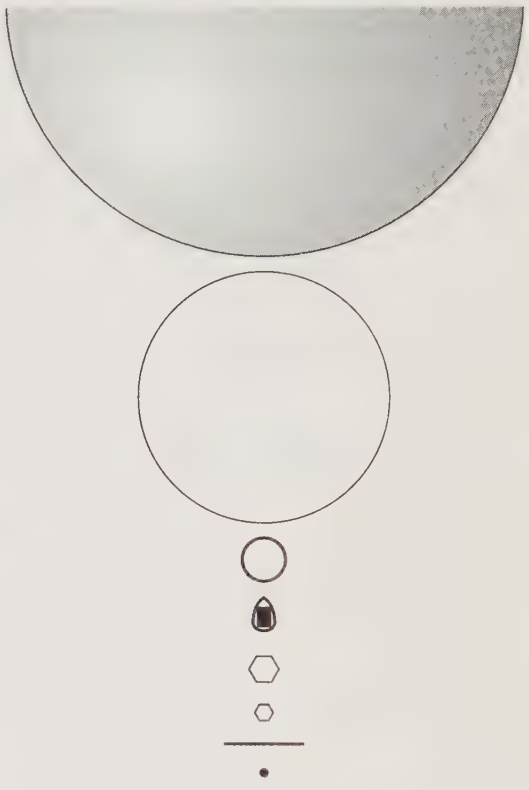
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• Viruses

The Size of Viruses

Study the graph below. It shows the sizes of viruses, bacteria, and other structures. The largest is a red blood cell. The rest are important because they cause illness.

Cells	Largest Diameter (in μm)
Red blood cells	7500
Bacteria *Streptococcus*	750
Herpes simplex virus	130
Rabies virus	125
Flu virus	85
Polio virus	27
Virus that affects plants	15
Red blood cell molecule	15



After studying the graph, answer the following questions.

1. About how large is a red blood cell? _____
2. How large are the smallest viruses that affect plants? _____
3. What is the smallest thing shown on the graph? _____
4. The smallest viruses attack what kinds of organisms? _____
5. How do the rabies virus and the polio virus compare in size? _____

6. How large is the *Streptococcus* bacteria? _____
7. How large are human red blood cells? _____

 Red blood cell molecules? _____
8. In general, which are larger, viruses or bacteria? _____

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Chapter 16

ENRICHMENT

Use with Section 1

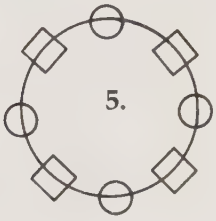
• What is classification?

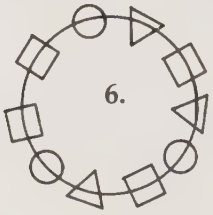
Classifying Patterns

Small children classify things when they sort blocks into piles according to color, shape, or texture. Scientists have many ways of classifying both organisms and information.

In this exercise, you will classify 12 different patterns. As pictured, these are different shapes in varied orders on a "string." You could just as easily use a specific color of bead to represent each shape. This would make it easier to work with the groups. Pretend the beads or shapes are different patterns of genetic information on a chromosome and it is your job to devise a way of classifying these differences in a meaningful way.

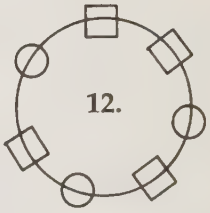
1. 
2. 
3. 
4. 







8. 
9. 
10. 
11. 



1. Can you divide these into two groups? _____What would each group have in common?

2. Examine each group and find a way to divide each into two groups. What does each group now have in common? _____

3. Repeat these steps until you have separated all twelve patterns into different categories. Draw a "tree" that splits into two at each choice, and write a short description indicating what the choice is at each step.

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• Modern Classification

Animal Characteristics

Animals are many-celled organisms that must obtain food to stay alive. Most animals can move about in the environment. About 95 percent of the known species of animals do not have backbones or skeletons inside their bodies. In the animal kingdom, animals are classified into nine main groups called phyla.

Use reference books and your textbook to find information to complete the table below.

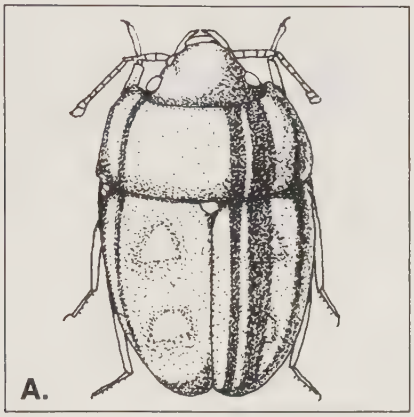
Animal Phyla Characteristics		
Phylum	**Common Name**	**Characteristics**
Porifera		
Cnidaria		
Platyhelminthes		
Nematoda		
Annelida		
Mollusca		
Arthropoda		
Echinodermata		
Chordata		

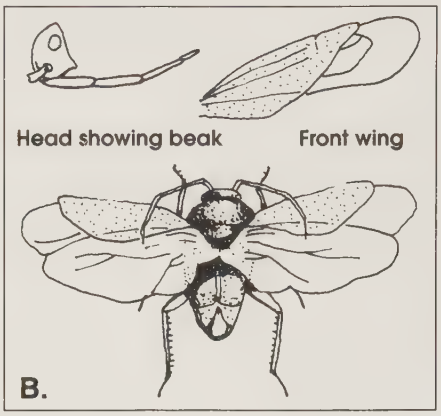
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• Identifying Organisms

A Bug or a Beetle?

Often we pick up an insect and casually refer to it as a bug or a beetle. Using scientific definitions, the insect may not belong to either of these orders of insects. Bugs belong to the order Hemiptera and beetles belong to the order Coleoptera. Look carefully at these two pictures and use the key below to find out which order these insects belong to. The key is not complete for all orders of insects, but it should help you tell the difference between bugs and beetles. There are a few wingless bugs that are not covered by this key. Use references if needed.





1. **Wing type**
 - **a.** Wings transparent. Go to step 2.
 - **b.** Front wings hard or leathery and covering hind wings. Go to step 2.
2. **Type of mouthparts**
 - **a.** Mouthparts chewing. Go to step 3.
 - **b.** No chewing mouthparts. Go to step 4.
3. **Wing venation**
 - **a.** Front wings with veins. Order: Orthoptera
 - **b.** Front wings without veins. Antennae usually 11 segments, often 8–10. Order: Coleoptera
4. **Front wing texture**
 - **a.** Front wings nearly always thickened at the base; membranous at tip; beak comes from front or bottom of head; antennae have 4 or 5 segments. Order: Hemiptera
 - **b.** Front wings of uniform texture; beak comes from hind part of head. Order: Homoptera

1. Which insect is a true bug and which is a true beetle? _____

2. What are some of the distinguishing characteristics of the insects shown? List them below.

	Bug	Beetle
Order:	_____	_____
Wings:	_____	_____
Antennae:	_____	_____
Mouthparts:	_____	_____

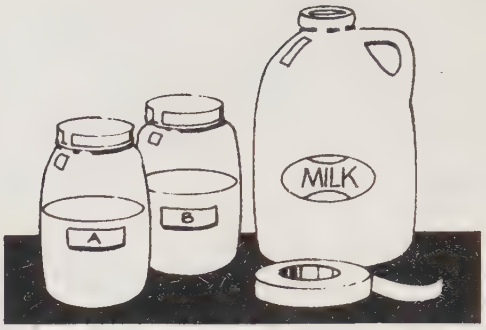
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• Two Kingdoms of Bacteria

How Temperature Affects Bacterial Growth

Materials

2 same-size clean glass jars with lids
refrigerator
fresh milk
pen
masking tape



Procedure

1. Pour milk into each jar, filling each about half full. Screw the lid onto each jar.
2. On each jar place a piece of masking tape. With a pen, label one "A" and the other "B."
3. Place jar A in the refrigerator. Place jar B in a warm place. Observe the contents of the two jars over a seven-day period.

Data and Observations

	Appearance	
	Day 1	Day 7
Milk in jar A		
Milk in jar B		

Conclude and Apply

1. What could have caused the change in jar B? _____

2. Since the jars were sealed, what can you say about the presence of bacteria in the milk when you poured it into the jars? _____

3. How did the temperature affect the growth of bacteria in the two jars? _____

4. From this experiment, what would you infer was the primary purpose of a refrigerator?

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Chapter 17

ENRICHMENT

Use with Section 2

• Bacteria in Your Life

Expiration Dates

Have you ever noticed the expiration dates marked on the foods you buy at the grocery store? These dates are marked by the manufacturer of the product to inform you of the last date the store can sell the food. After that date, within a few days to weeks, depending on the type of food, the population of bacteria in the food will make the food unsafe to eat.

Procedure

Look in your cupboard and refrigerator at home and find the expiration dates on six foods. Record what you have found in the table below. Then answer the questions that follow.

Data and Observations

Food	Expiration date	Location of date	Description of container

Conclude and Apply

1. Where was the date usually found? _____

2. Shelf life is how long a food can be stored and is still safe to use. Which food had the shortest shelf life? _____

3. Which food had the longest shelf life? _____

4. In what kind of container was the food with the longest shelf life? _____

5. Why do you think this product has a long shelf life? _____

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• Kingdom Protista

Protists in a Jar



Materials

grass or hay that has not been chemically treated
pond water
glass jar with top
magnifying lens

Procedure

1. Put a handful of grass or hay into the jar.
2. Fill the jar about half full with pond water.
3. Place the top on the jar, but do not screw it on. Then put the jar in a dark place for three or four days.
4. After three or four days, observe the contents of the jar. Use your magnifying lens to study the contents.

Data and Observations

1. What can you see with your magnifying lens? Describe any protists you observe. _____

2. Do any of the protists appear to be moving? _____

3. Draw the protists you observe in the space below.

Conclude and Apply

1. What structures do protists have that allow them to move from place to place? _____

2. Why might some of the protists look green? _____

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NAME DATE CLASS

Chapter 18

ENRICHMENT

Use with Section 2

• Kingdom Fungi

What makes dough rise?

Materials

1 cup flour
1 tablespoon of sugar
1 package of dried baker's yeast
measuring cup
glass jar
marker
clock
warm tap water
spoon



Procedure

1. Put the flour and sugar into the glass jar.
2. Put 1/4 cup warm tap water into the measuring cup. Add the package of yeast, stirring with a spoon.
3. Slowly stir the yeast water into the flour and sugar mixture. Stir until dough forms. Push the dough down to the bottom of the jar. Mark the height of the dough on the outside of the jar.
4. Put the jar in a warm place. You could put it by a heat outlet or place the jar in a pan of warm water.
5. Watch the clock. Every ten minutes, mark the height of the dough on the outside of the jar. Continue this for an hour.

Conclude and Apply

1. What happened to the dough during the hour? _____

2. What kind of fungus is the yeast you added? _____
3. What does yeast use for energy? _____
4. What did you add that acted as food for the yeast? _____
5. What are the waste products when yeast consumes food? _____
6. After an hour, could you see any bubbles in the dough? _____
7. What gas could you conclude caused these bubbles? _____
8. What made the dough rise? _____

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• Characteristics of Plants

Sweet Celery

The following activity will show you how a vascular plant moves nutrients to all its parts.

Materials

2 fresh, washed stalks of celery with leaves (stalks from the middle of the bunch work best)
2 tall glasses
sugar
measuring spoons
masking tape
pen



Procedure

1. Fill each glass half full with water.
2. Add 4 tablespoons of sugar to one of the glasses. Label the glass "sweet" on a piece of masking tape.
3. Label the other glass "water."
4. Put a celery stalk in each glass and leave them for 48 hours.
5. Taste the leaves from each stalk. **CAUTION:** *Never taste anything in a lab setting. This activity is safe because it uses only celery, sugar, and water.*

Data and Observations

1. How did the celery leaf from the sugar water taste? _____

2. How did the celery leaf from the plain water taste? _____

Conclude and Apply

1. How did the sugar get from the water to the celery leaf? _____

2. How do plants get nutrients from the soil to their leaves? _____

3. What advantages do plants with this adaptation have? _____

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Chapter 19

ENRICHMENT

Use with Section 2

• Seedless Plants

Ferns

The fossil record shows that ferns first appeared almost 400 million years ago. There are many fern species living today. Most of these 1200 fern species live in the tropics, although some live in temperate and arid regions. Ferns vary in size from tiny, mosslike species to giant treelike forms. One treelike form found on Norfolk Island in the South Pacific can reach a height of almost 30 meters. The structure of the fern leaf, or frond, is well adapted to the filtered light of forests. The fronds are widely spaced and divided into leaflets, called pinnae, which are angled to catch the light. The spores of the fern are clustered together in the sori.

Draw a fern and label the parts. Include the terms frond, pinnae, sorus and rhizome.

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• Seed Plants

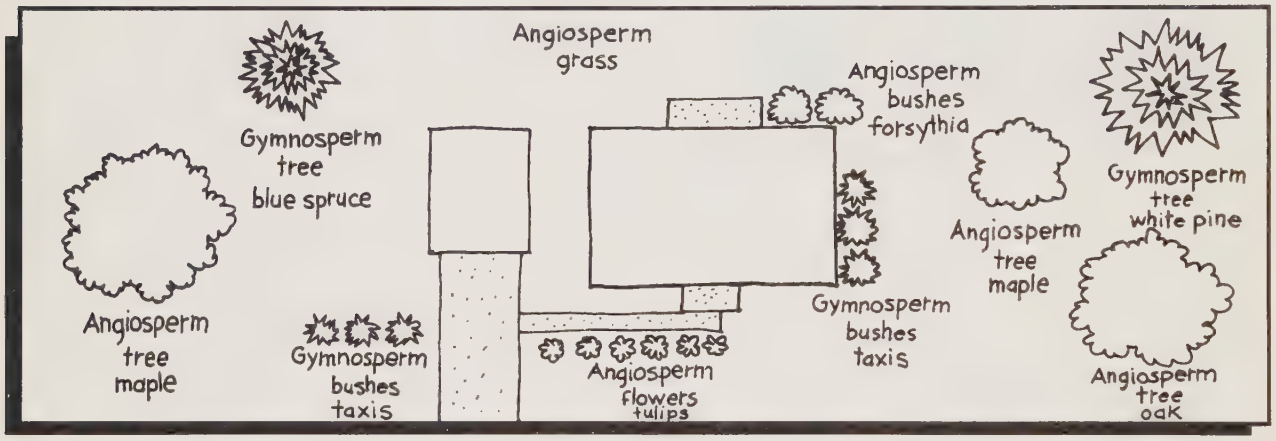
Mapping Gymnosperms and Angiosperms

Materials

paper
pencil

Procedure

Choose an area with which you are familiar—a yard or a small park or the school grounds. Using a blank sheet of paper, make a map of the area that shows the major plants and identifies them as either gymnosperms or angiosperms. Make your map similar to the one below.



Identify the plants you map as specifically as you can. As shown on the example map, first write "Angiosperm" or "Gymnosperm." You may use information in your textbook to help you identify the plants as one or the other. Then, write a general term such as "tree," "bush," "flower," or "grass." Finally, write the specific name for any plants that you know. Ask adults for help. Many adults will be glad to tell you the names of the bushes and trees they have planted in their yards. Also, you can find books on tree and bush identification in almost any library.

Conclude and Apply

1. Did you find more angiosperms or gymnosperms? _____

2. Of the angiosperms you identified, which are monocots and which are dicots? _____

3. What can you conclude about the variety of plants in an area? _____

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NAME DATE CLASS

Chapter 20

ENRICHMENT

Use with Section 1

• What is an animal?

Looking at Animal Characteristics

Your textbook names five characteristics that all animals have in common. Prove to yourself that together, these characteristics define only animals. First, briefly write a description of each characteristic. Then, fill in the table of living things by writing yes or no in each box, depending on whether that living thing has that characteristic.

Characteristic 1:_____

Characteristic 2:_____

Characteristic 3:_____

Characteristic 4:_____

Characteristic 5:_____

When completing the table below, you may look at other chapters in your textbook or consult an encyclopedia.

Living thing	Characteristics 1	2	3	4	5
kelp					
bacterium					
bird					
dog					
fern					
fish					
flatworm					
insect					
jellyfish					
lobster					
mushroom					
paramecium					
snail					
tree					

Which organisms are animals?_____

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Chapter 20

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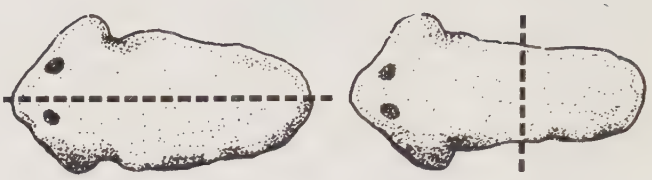
Use with Section 2

• Sponges, Cnidarians, Flatworms, and Roundworms

Planarian Regeneration

Materials

- large wide-mouth jar
- hand lens
- pond water
- spring water at room temperature
- cooked egg yolks or raw meat
- magnifying glass
- art knife



Procedure

1. Planarians can be found near the shoreline of ponds that have decaying leaves and other debris. Fill your wide-mouth jar with this shoreline material and a few inches of pond water.
2. Let the jar sit overnight. In the morning, planarians will likely be clinging to the sides of the jar. Planarians look like small, dark, jelly-like blobs. Remove much of the shoreline material, and add some more pond water.
3. Using the magnifying glass and art knife, carefully cut two planarians in half as shown above. **CAUTION:** *The art knife is very sharp. Be careful when using sharp objects.* Return cut planarians to the jar.
4. Once a day, feed the planarians some egg yolk or raw meat. After about an hour, remove the remaining egg yolk or meat, drain as much of the water away as possible, and replace with fresh pond water or bottled spring water.
5. Observe the planarian parts for a week and then return them to a pond.

Data and Observations

What do your planarian parts look like after a week? _____

Conclude and Apply

1. Why did the planarian parts change? _____

2. How would regeneration affect the planarian population? Explain your answer.

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Chapter 20

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Use with Section 3

• Mollusks and Segmented Worms

Snail Behavior

As you know from your textbook, snails are a type of mollusk in the class known as gastropods. Snails like damp, dark environments and can be found under leaves and near rotting logs. When searching for snails, go to a natural area in a park or woodlot. Use gloves when picking up snails. Handle them gently.

Materials

- old aquarium or clear wide-mouthed jar
- glass top for aquarium or jar lid with holes
- fresh lettuce
- snails



Procedure

1. Search for snails near a rotting log. Turn over moist logs, boards, or leaves.
2. Place the snails into an aquarium or jar along with woodland materials. Punch holes in the top of the jar for air, or place a glass top over the aquarium leaving a small opening for air.
3. Feed the snails fresh lettuce every day.
4. Observe the snails eating.
5. Watch for snail activity during daytime hours and during nighttime hours.
6. For one 24-hour period, place the jar or aquarium into a dark closet during the day and shine a strong light onto the environment during the night. Observe the snails' activity.

Observations

1. How fast does a snail move? _____

2. How long does it take a snail to eat a leaf of lettuce? _____

3. Were the snails more active during the day or night? _____
4. What happened when you changed the pattern of light? _____

5. From your observations, would you conclude that snails in their natural environment are more active at night or during the day?

When your observations are completed, return the snails to their natural environments.

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Chapter 20

ENRICHMENT

Use with Section 4

• Arthropods and Echinoderms

Crickets

A common arthropod of the insect class is the cricket, a small bug with antennae, wings, and powerful hind legs. The word *cricket* comes from a French word meaning "to click or creak." Anyone who has had a cricket in the house has observed their noise-making abilities. Crickets can easily be found from spring through fall in fields and vacant lots. They can also be purchased at bait stores that sell fishing supplies or pet stores.

Materials

- wide-mouthed clear glass jar
- rubber band
- old nylon stocking
- scissors
- thermometer
- clock with second hand
- crickets

Procedure

1. Catch a cricket in a field or buy one from a pet or bait store.
2. Place the cricket in the jar. Cut a top for the jar from the old nylon stocking. Secure the cover with the rubber band.
3. Observe the cricket's body parts and make a sketch of the arthropod. Label your sketch with these terms: head, thorax, abdomen.
4. Wait until the cricket is chirping regularly. While watching the second hand of the clock, count how many chirps the cricket makes in 15 seconds. Add 40 to the number of chirps you counted. Compare that sum to the temperature of the room.
5. Move the jar to a warmer place (near a sunny window, for example). Make your count again.

Observations

Draw your sketch here.

Conclude and Apply

1. How did the sum of the number of chirps compare with the temperature reading?

2. What happened to the number of chirps when you moved the jar to a warmer place?

3. How does temperature affect cricket activity? _____

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• Fish

Chordate Hearts

The hearts of fish, amphibians, and reptiles are all different. This is because each type of animal has different needs and different body functions.

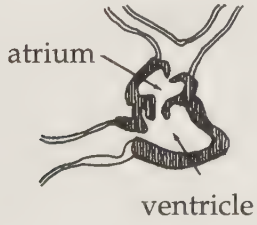
Fish have hearts with only two chambers, an atrium and a ventricle. Their blood flows in a simple path from the heart to the gills, where it is oxygenated, to body tissues, and back to the heart. This two-chambered heart supports the life of the fish because fish don't need as high a level of energy for body functions as land vertebrates. Fish are supported and buoyed up by the water they live in.

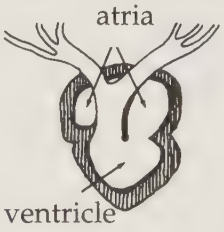
Amphibians and reptiles have a more complex circulatory system than fish. This better enables them to deal with the environmental problems of living on land. Amphibians and reptiles have a third heart chamber that helps the heart to keep oxygenated and deoxygenated blood separate.

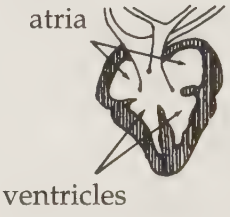
Amphibians carry on respiration through their skin as well as lungs. Unlike fish, they have two atria instead of one. One atrium receives oxygenated blood from the lungs, and the other receives deoxygenated blood from body tissues. Both atria empty into a single ventricle. The ventricle lets blood bypass the lungs when the animal is under water.

Reptiles don't have skin respiration. Reptile hearts have two atria and a ventricle. But unlike the amphibian's, the reptile heart has a partially divided ventricle. This wall further decreases the mixing of oxygenated and deoxygenated blood and allows oxygenated blood to be pumped continually to the body.

Decide if the following are hearts of fish, amphibians, or reptiles. Label the diagrams, then answer the questions that follow in complete sentences.







_____ _____ _____

1. Summarize how the number of chambers in the hearts of fish, amphibians, and reptiles relates to their lifestyles. _____

2. Why do you think humans and birds have a more advanced type of heart than fish, amphibians, and reptiles? _____

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• Amphibians and Reptiles

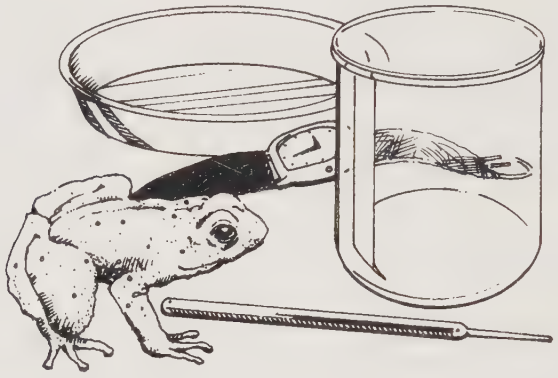
Designing an Experiment

Amphibians hibernate during the cold winter months, burying themselves in mud or leaves until the temperature rises. They don't eat and they barely move during hibernation. Their bodies slow down. Do you think that their internal body processes also slow down? One internal process that you can observe in a frog is its breathing, because you can watch the movements of a frog's throat as it breathes in air. To find out how temperature affects breathing, you could count the frog's breaths and relate them to temperature.

With those thoughts in mind, design an experiment that would examine the effect of changes in temperature on amphibian body processes. Use the materials listed below in your experiment design. You can add other materials if you wish. Write the step-by-step procedure of how you would perform your experiment. Then, write a statement of what you would expect the results of the experiment to be. Remember, you don't want to harm the amphibian in any way.

Materials

- frog or other amphibian
- thermometer
- glass jar
- ice
- warm water
- pan
- clock or watch



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• Birds

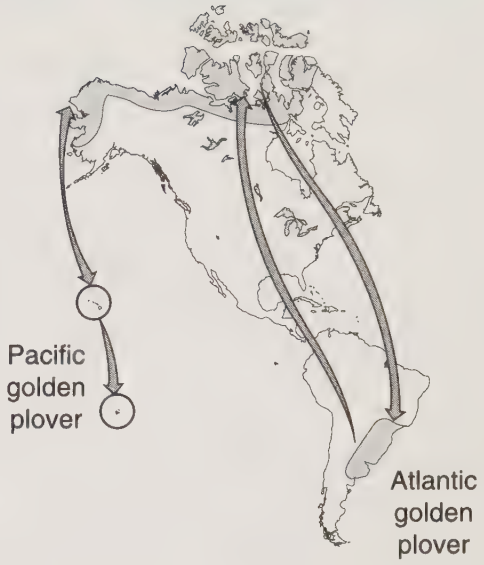
Migration of Birds

Many animals, particularly birds, have a remarkable ability to migrate over thousands of miles of land and sea. Yet we know very little about how they do this. Clearly these animals must have special mechanisms of navigation and orientation.

The Atlantic golden plover flies over 8000 miles from the northernmost part of Canada, its arctic breeding ground, to an area of the southeastern part of South America. Perhaps it is even more extraordinary that the Pacific golden plover finds its way from the Western region of Alaska to the Hawaiian and Marquesas islands—relatively small pieces of land in the vast Pacific Ocean.

After much research, scientists have determined that these birds migrate by the sun and stars. Some species of birds cannot migrate successfully in cloudy weather. However, many other species continue to migrate under clouds and through fog. This posed another problem for scientists.

After many experiments, it was confirmed that by combining information from two sources, birds can point themselves in a particular compass direction. These sources are the sun or constellation of stars, and their "internal clocks," which are related in some way to 24-hour periods. But even this does not explain birds' ability to migrate on a cloudy day or starless night.



There is much experimental evidence that birds can detect Earth's magnetic field and orient themselves with it. Very little is known about how birds detect magnetism. However, bits of magnetite, a magnetic iron ore, have been found in the heads of pigeons. It is assumed at present that the magnetite is involved in some way in the pigeon's "magnetic sense." Indeed, scientists have upset a pigeon's flight pattern by attaching a small magnet to the bird.

Much has been learned about navigation and orientation of birds and other animals. Yet scientists are far from understanding how birds can migrate with such accuracy for great distances year after year.

Question and Observations

1. Until fairly recently how were birds thought to orient themselves on a long, migratory flight?

2. What recent discovery helps to explain how birds can fly in a particular compass direction?

3. How does a homing (messenger) pigeon find its way from the coast of France to its cage on the roof of a London apartment house? _____

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• Mammals

Observations of a Mammal

You will observe characteristics of a mammal in the following activity.

Procedure

Choose a family pet or some pet you know well in the neighborhood. Make sure the pet is a mammal. Pets might include a dog, a cat, a rabbit, a gerbil, a horse, or a mouse. Observe the mammal, keeping in mind the characteristics that you learned about in your textbook. Add to your observations by looking in an encyclopedia or some other reference book that might include information about your mammal. Complete the table below with your observations and the information you gained by reading about this mammal.

Data and Observations

Characteristic	Observation/Information
Animal type	
Scientific classification (kingdom, class, order)	
Outer covering	
Teeth	
Food	
Reproduction (type, mammal classification, gestation period)	
Other characteristics	

Conclude and Apply

1. After observing the mammal's teeth and food choices, would you classify it as an herbivore, a carnivore, or an omnivore? _____
2. What characteristics of the mammal you observed seem to make it well suited to living in your home or neighborhood? _____

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Chapter 22

ENRICHMENT

Use with Section 1

• Types of Behavior

Animal Behavior Research

The Austrian scientist Konrad Lorenz and the Dutch zoologist Niko Tinbergen were the founders of an approach to behavior called ethology. These two men shared the 1973 Nobel Prize in medicine and physiology with the German biologist Karl von Frisch. **Ethology** is the study of animal behavior in nature, and is concerned with innate behavior patterns. Instincts and reflexes are innate behaviors.

Learned behavior is acquired as the result of experience. There are several kinds of learned behavior. **Habituation** is a form of learning in which an animal learns not to respond to a stimulus. Animals may learn not to respond to stimuli that are repeated frequently and that are unimportant to them. Conditioning is another type of learned behavior. There are two kinds of conditioning. Ivan Pavlov, a Russian psychologist, knew that dogs respond to the smell of food by salivating. This response is innate. Pavlov wanted to know if the salivation response could be caused by a less likely stimulus. Pavlov rang a bell at the same time the dog was given food. Eventually, the sound of the bell was enough to cause the dog to salivate. This type of conditioning is known as **classical conditioning.**

The American psychologist B.F. Skinner used pigeons to study another type of conditioning. He realized that if a certain behavior were followed by a reinforcement or reward, the behavior was more likely to be repeated in the future. To study this phenomenon, he invented the Skinner box. The box contained a typewriter-like key connected to a food supply. If the pigeon pecked at the key, it would be rewarded with food. This type of learning is called **operant conditioning.** If the response is reinforced with a reward, the behavior tends to be repeated.

Determine if the following behaviors are innate or learned. If the behavior is innate, determine if the behavior is an instinct or a reflex. If the behavior is learned, determine if the behavior is habituation, classical conditioning, or operant conditioning.

1. The first time a squirrel sees a nut, it tries to bury it. _____ _____

2. Jane touches a hot curling iron and jerks her hand away. _____ _____

3. John is startled by a loud noise outside his window. The same noise is repeated several times, but John no longer responds. _____ _____

4. Cindy is teaching her dog tricks. When the dog rolls over at her command, she rewards it with praise. _____ _____

5. A planarian moves away from bright light. It curls up when electrically shocked. When a bright light is closely followed by an electric shock, the planarian curls up. Eventually, the light alone causes the planarian to curl. _____ _____

6. Kittens stalk imaginary prey. _____ _____

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Chapter 22

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Use with Section 2

• Behavioral Adaptations

Adaptations for Night Living

Many animals sleep during the day and become active at night. These animals are nocturnal. When we think of all the things an animal must do to survive, it is apparent that night living requires some special sensory adaptations. An owl has such good hearing that it can pick up the smallest sounds of a rodent stepping over dry leaves or twigs 23 meters away!

Procedure

Use the library to find out more about nocturnal animals such as the owl. Fill in the table below with information gathered from your library research.

Data and Observations

Sensory Adaptations for the Owl	
Vision	
Position of eyes:	
Size of eyes:	
Hearing	
Size of ear openings:	
Directing sound into ear openings:	
Other adaptations for hunting and foraging at night:	

Conclude and Apply

1. What is another animal you have read about that is nocturnal? _____

2. What adaptations does it have for night living? _____

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Chapter 1

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Use with Section 1

• How Science Works

Archaeology Volunteers

There are many opportunities for volunteers to share in archaeological discoveries. Here are some examples:

Dinosaur Excavation, Montana
Tasks: Volunteers will plot locations of fossils on a topographic map, construct trenches for excavation, excavate fossils using hand tools, and screen-wash sediment to sort fossils.

Maya Ruin, Belize
Tasks: Volunteers will participate in field surveys, making maps, taking photographs, excavating, recording, and cataloging.

Hopi Ruin, Arizona
Tasks: Volunteers will work in both the field and the lab. Field work includes excavating, photographing, mapping Hopi artifact locations, and completing forms. Lab work includes washing, cataloging, sorting, and analyzing ceramics, stone items, and bone and shell tools.

Mammoth Remains, South Dakota
Tasks: Volunteers will use shovels, brushes, and dental tools to excavate bone beds. They will map, record data, and stabilize and preserve bone.

Answer the following questions, using complete sentences.

1. What skills might be useful for a person wishing to volunteer for an archaeological dig?
Sample Answer: photography, ability to identify the types of artifacts that might be found on the expedition, map making, drawing, surveying

2. What sciences are used in these archaeological studies?
Sample Answer: Earth science, biology, chemistry, botany, geology

3. Suppose you could volunteer at one of these sites for two weeks. Which would you choose? Why?
Sample Answer: Maya Ruin, Mexico, because my family is from Mexico and I am learning photography.

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Chapter 1

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Use with Section 2

• Scientific Problem Solving

Inductive Reasoning

When you draw a conclusion based on a number of observations, you are using inductive reasoning. By this process, you make a general statement based on specific examples. The following are examples of inductive reasoning.

Problem to solve:	What percent of the seeds in a package will sprout?
Observations:	In three tests of 100 seeds each, 95, 89, and 92 seeds sprouted.
Conclusion:	About 92% of the seeds in a package will sprout.
Problem to solve:	Which of the two cars in a race is faster—the blue car or the red car?
Observations:	In 5 tests of 10 laps each, with the same driver, the blue car's time was always faster.
Conclusion:	The blue car is the faster car.

The conclusions that result from inductive reasoning only reflect the observations that were used to make them. If other factors would affect the conclusion but were not observed, the process may produce misleading results.

1. Suppose all of the seed tests were done at the same time in the same type of soil and weather conditions. What limitations would that put on the conclusion that 92% of the seeds in a seed package will sprout?
The conclusion would be valid only for the conditions that were tested. However, not all seeds will be grown under those same conditions, so more experiments should be done under more varied conditions before a general claim is made.

2. What if, unknown to the experimenter, a wheel on the red car was loose? What effect could that fact have on the validity of the conclusion that the blue car is the faster car?
The loose wheel might have slowed the red car. The conclusion would still be valid if the experiment sought to compare the cars "as is," but would not be valid if it sought to compare speeds based on the design of the cars.

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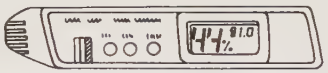
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Use with Section 1

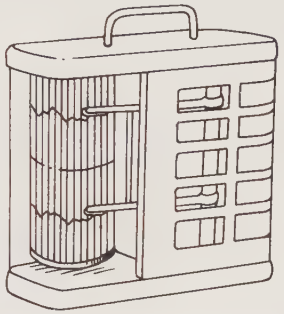
• Description and Measurement

Weather Instrument Precision

The symbol ± is used to show precision in measuring devices. For example, ±3°C means that the actual temperature may be 3°C greater or 3°C less than the temperature shown on the instrument.



Max/Min Thermohygrometer
Digitally displays relative humidity and temperature
Measures relative humidity from 25% to 95% with precision ±5% RH
Measures temperature 0°C to 50°C with precision ±2°C



Battery Operated Hygrothermograph
Measures relative humidity and temperature and records them on a chart
Measures relative humidity from 5% to 99% with ±3% RH precision
Measures temperature from –10°C to 50°C with ±1°C precision

Answer the following questions, using complete sentences.

1. Describe ways these two instruments are alike.
Both measure relative humidity and temperature.

2. Describe the differences between these two instruments.
The temperature and relative humidity ranges as well as precisions differ. The way the data are displayed varies.

3. How precise are the measurements for each instrument?
The thermohygrometer is precise to the nearest 2°C and the nearest 5% RH; the hygrothermograph is precise to the nearest 1°C and the nearest 3% RH.

4. If the display on the thermohygrometer shows 15°C, between what temperatures might the actual temperature fall? How do you know?
13°C to 17°C—The instrument is precise to ±2°C.

5. Suppose the thermohygrometer shows 52% relative humidity and at the same time the hygrothermograph shows 55% relative humidity. What would you expect to be the actual relative humidity? Why?
The thermohygrometer is precise to ±5%. For 52% that is 47% to 57%. The hygrothermograph is precise to ±3%. For 55% that is 51% to 58%. So, you might expect the actual relative humidity to be between 51% and 57%.

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Chapter 2
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Use with Section 2

• SI Units

Defining the Meter

Over the years, scientists have used different ways to set the exact length of the meter. In 1790 it was suggested that the meter be defined as the length of a pendulum having a period of one second.

In 1791 it was proposed that the meter equal one ten-millionth of the distance at sea level from the north pole to the equator. In 1799 a platinum bar one ten-millionth of the length of the part of the meridian that reached from the north pole through Paris to the equator was created as the prototype for the meter. This bar, the Metre des Archives, was one meter long from end to end at 0°C. In 1889 a meter bar made of platinum and iridium and measured at 0°C became the standard.

In 1960 a definition based on the wavelength of krypton-86 radiation in a vacuum was instituted. The definition changed again in 1983, when the current definition was established. A meter is now defined as the length traveled by light in a vacuum in 1/299 702 458 of a second.

1. What other unit needed to be standardized before the meter could be defined under the 1983 definition?
The length of a second had to be standardized.

2. What are some possible problems with using a physical model as a prototype?
Physical dimensions change with temperature, pressure, and location. If used often, physical models may wear down and lose accuracy.

3. Why was it necessary to specify a particular meridian when determining the length of a meter?
Different meridians have different lengths because Earth is not perfectly round.

4. How precise is an everyday meterstick compared to the length of the standard meter?
Everyday metersticks are subject to changes based on environmental conditions and physical wear. Their lengths may vary. The standard length of a meter is very precise.

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Chapter 2

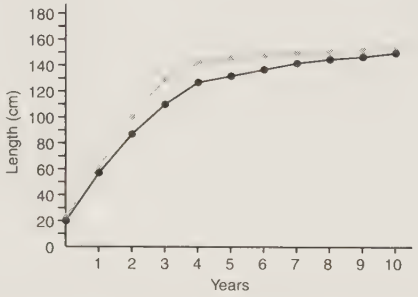
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Use with Section 3

• Communicating Data

Double Data

The double line graph shows the growth of two alligators. The vertical scale shows the length in centimeters.



1. Is a double line graph appropriate for presenting the alligators' growth? Explain.

 Yes, the lines show the growth of the alligators over time. Having both lines on the same graph makes it easy to compare them.

2. At what age was the difference in the two alligators' lengths the greatest? Explain how you determined your answer.

 The difference between the two alligators' lengths was greatest at age three. The farther apart the lines on the graph are, the greater the difference in the lengths. The two lines are farthest apart at age three.

3. How can you use the graph to figure out when each alligator grew the most?

 You can look at how steep the lines on the graph are. Steeper lines show greater growth. Both alligators grew the most between ages one and three.

4. Write a description comparing the lengths and growth of the two alligators at various ages.

 Sample answer: Alex has always been longer than Alice. They were closest to the same length at age one. Each year through age seven, Alex grew a little more than Alice did. Between the ages of seven and nine, Alice grew more than Alex.

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NAME DATE CLASS

Chapter 3

ENRICHMENT

Use with Section 1

• Structure of Matter

Flow, Flow, Old Phlogiston!

Before Antoine Lavoisier developed the oxygen theory of burning and rusting, most scientists believed in the phlogiston (floh JIHS tuhn) theory. Each theory is briefly described below.

- **Oxygen Theory.** When wood burns, it combines with the oxygen in the air to form new substances—carbon dioxide, water, and ash. When iron rusts, it combines with the oxygen in the air to form a new substance, iron oxide. In both cases, the total mass of the original substance and the oxygen it combines with equals the total mass of the resulting substances.
- **Phlogiston Theory.** Wood is made up of ash and a substance called phlogiston. When wood burns, it gives off phlogiston into the air, leaving the ash. Iron is made up of metallic ash (now called iron oxide) and phlogiston. When iron rusts, it gives off phlogiston into the air, leaving the metallic ash.

Answer the following questions, using complete sentences.

1. Two experiments that scientists used to test the phlogiston and oxygen theories involved burning wood in a closed container filled with either pure nitrogen or pure oxygen instead of air. (Air consists of 78% nitrogen, 21% oxygen, and 1% other gases.) The wood would not burn in the nitrogen container, but it burned vigorously in the oxygen container. Which theory do these results support? Explain.

 The results support the oxygen theory. According to the phlogiston theory, the wood should burn (give off phlogiston) in both containers. Because the wood does not burn in nitrogen, that implies oxygen is needed for burning.

2. When iron rusts, the resulting substance has a greater mass than the original iron. Which theory does this result seem to fit better? Explain.

 The result fits the oxygen theory better. According to the phlogiston theory, iron rusts by giving off phlogiston. So, the resulting substance should have lesser mass. According to the oxygen theory, iron rusts by combining with oxygen. So, the resulting substance should have greater mass.

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Chapter 3

ENRICHMENT

Use with Section 2

• Elements: The Building Blocks of Matter

The Periodic Table

Use a periodic table to complete the first four columns of the chart below. Then use the Internet or research books, such as a dictionary or encyclopedia, to complete the last column. When you have finished, answer the question below.

Element	Symbol	Number of protons	Atomic mass	Metal, nonmetal, or metalloid	Answers in this column will vary. Sample answers are shown below. Characteristics and uses of elements
Hydrogen	H	1	1.008	nonmetal	colorless gas; bonds with oxygen to form water
Carbon	C	6	12.011	nonmetal	found in all living tissue; also in diamonds, charcoal, and graphite
Oxygen	O	8	15.999	nonmetal	colorless, tasteless, odorless gas; most abundant element in Earth's crust
Sodium	Na	11	22.990	metal	silvery-white, waxy metal; found naturally only in combination with other elements
Silicon	Si	14	28.086	metalloid	second most abundant element in Earth's crust; used for transistors and computer chips
Iron	Fe	26	55.847	metal	malleable and ductile; most-used metal
Krypton	Kr	36	83.80	nonmetal	rare gas found in air; reacts only with fluorine
Chlorine	Cl	17	35.453	nonmetal	yellow, poisonous gas; used as a bleach and in water purification
Plutonium	Pu	94	242	metal	radioactive, isotope 239 is used in nuclear weapons and as reactor fuel
Lead	Pb	82	207.19	metal	soft, high density, and bluish-gray solid
Silver	Ag	47	107.870	metal	extremely ductile and malleable; best conductor of heat and electricity

Name three things that you can predict about an element just by knowing its position on the periodic table. **Responses may include: number of protons; probable atomic mass of an atom; whether an element is a metal, nonmetal, or metalloid; whether it is malleable or ductile; whether it conducts heat and electricity.**

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Chapter 3

ENRICHMENT

Use with Section 3

• Compounds and Mixtures

Compounding Compounds

Part A

You should already know that the formula for water is H_2O. However, did you realize that hydrogen and oxygen, the two elements in water, are found in thousands of compounds? Use research books such as encyclopedias or dictionaries to complete the columns in the table below.

Common name	Chemical name	Formula	How many atoms of hydrogen? Oxygen?	What other elements are in the compound?	This is sample data. Answers will vary. Description/Uses
Wood alcohol	methyl alcohol or methanol	CH_3OH	4 hydrogen; 1 oxygen	carbon	colorless, poisonous; fuel, solvent
Ammonia cleaning solution	ammonium hydroxide	NH_4OH	5 hydrogen; 1 oxygen	nitrogen	solution made from ammonia (colorless gas) and water; used for household cleaning
Baking soda	sodium bicarbonate	$NaHCO_3$	1 hydrogen; 3 oxygen	sodium; carbon	white powder; antacid, makes bread rise
Sugar	sucrose	$C_{12}H_{22}O_{11}$	22 hydrogen; 11 oxygen	carbon	white crystals, sweet taste; food flavoring
Vinegar	acetic acid	CH_3COOH	4 hydrogen; 2 oxygen	carbon	sour taste; food preservation and flavoring
_____	_____	_____	_____ _____	_____	_____ _____
_____	_____	_____	_____ _____	_____	_____ _____

Part B

Can you think of any other compounds that contain hydrogen and oxygen? Add at least two additional compounds to the table and complete the columns for these compounds.

Answers will vary. Make sure that the formulas for these additional compounds contain both hydrogen and oxygen.

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Chapter 4

ENRICHMENT

Use with Section 1

• Physical and Chemical Properties

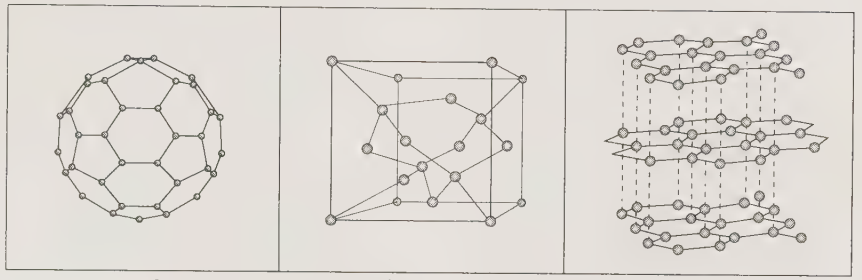
Properties of Carbon

Carbon is one of the most common elements in the world. It forms the tissue of every living creature from an elephant to a spinach leaf. It makes up the products we use to fuel our cars and heat our homes. In one form, it is so soft that it easily rubs off on paper. In another form, it is the hardest natural material known. For years, scientists have explored how the same element can make such very different substances.

One answer is that each carbon atom has four electrons in its outer shell (or orbit). Because the outer shells of most atoms can hold eight electrons, carbon atoms easily form bonds with many other kinds of atoms—including other carbon atoms. However, carbon atoms can bond in several different ways. The drawings below show three different forms of carbon. The circles represent atoms; the lines represent chemical bonds holding the atoms together.

Which properties do you think go with each form of carbon?

Draw a line to the sketch that matches each form. Then on the lines beneath each form of carbon, write the number of the descriptive phrase (from the box below) that fits that form.



Diamond— 1 , 4 , 8 Graphite— 3 , 5 , 6 Fullerene— 2 , 7 , 9

Which of these descriptive phrases goes with which compound?

1. The hardest natural structure
2. A recently discovered type of carbon, also known as "buckeyballs"
3. A soft type of carbon that rubs off easily on paper
4. Clear crystal
5. Used in pencil lead
6. Conducts heat and electricity
7. Scientists use it as a "cage" to hold other atoms
8. Used to cut glass and steel
9. Added to lubricants

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Chapter 4

ENRICHMENT

Use with Section 2

• Physical and Chemical Properties

Things Are Heating Up . . .

Burning a piece of wood causes a chemical change to occur. The matter in the wood changes to produce gases and charcoal. Heat can cause many kinds of chemical changes, but not all changes caused by heat are chemical changes. Often, heat causes a physical change.

Heating or cooling materials can change their state from solid to liquid, liquid to gas, or back again. These changes in the state of matter are physical changes. When water freezes or melts, a physical change has occurred.

Most materials expand when they are heated and contract as they cool. Two exceptions to this rule are water and rubber. These substances expand when they are cooled and contract when they are heated. For example, when water freezes, it expands to fill a larger space than the liquid water did.

Use this information and what you already know about matter to answer the questions below.

1. Why should you never put a full, sealed bottle of water in the freezer?
 You should never put a full, sealed bottle of water in the freezer because the water will expand as it freezes, breaking the bottle.

2. Why are many bridges built with gaps (called expansion joints) in them?
 In hot weather, the matter that makes up the bridge expands. The expansion joints give the bridge some space to expand into. Without these gaps, the bridge could buckle and crack.

3. Think about it. . . why should you never pour hot liquids into a cold drinking glass?
 As the hot liquid touches the glass, the glass begins to expand, but not all at the same time. The side next to the hot liquid starts to expand before the side away from the hot liquid. The difference in expansion rates causes the glass to crack.

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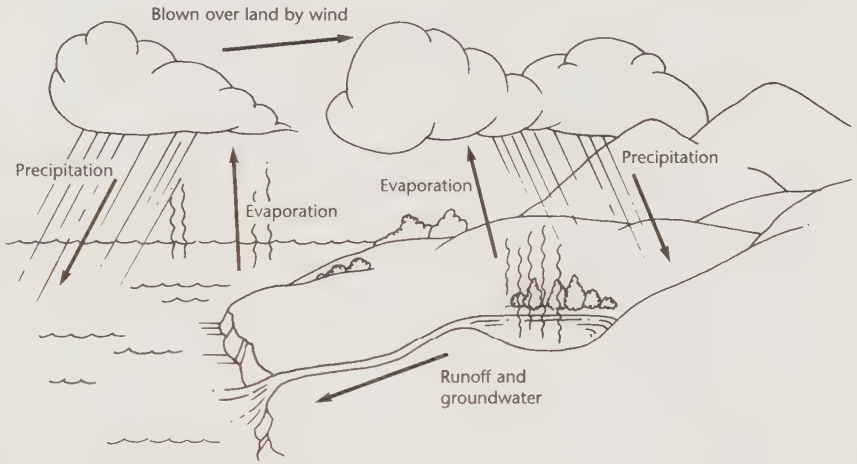
Chapter 5
ENRICHMENT

Use with Section 1

• Energy and How It Changes

The Hydrologic Cycle

This model of the hydrologic, or water, cycle shows the circulation of Earth's water. Water evaporates from oceans, inland waters, and vegetation. As the water vapor cools, it condenses to form clouds. Moisture is transported by the clouds and deposited as rain, snow, or hail. Some of the precipitation is absorbed by the ground and becomes groundwater. Some of it returns to rivers, lakes, and oceans as runoff.



Answer the following questions, using complete sentences.

1. Describe the transfer of energy in this system.
Possible Answer: Energy from the sun causes evaporation; decrease in heat causes formation of clouds; energy of the wind transports the clouds; and gravity causes precipitation and runoff.

2. Is the water in this system conserved? Do you think the total amount of Earth's water remains the same? Explain your thinking.
Possible Answer: The water may be in solid, liquid, or vapor form as it moves through the hydrological system, but the total amount of water in the system remains constant.

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Chapter 5
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Use with Section 2

• Temperature and Thermal Energy

In the Eye of the Hurricane



Many people have seen or read news reports about hurricanes. To some people, they are fierce displays of how devastating nature can truly be. To others, they are beautiful reminders of the energy found in Earth's environment. Scientists also see hurricanes as intriguing events worthy of great attention and study.

Many forces combine to form a hurricane, including the temperature of ocean water and the collision of winds blowing from the east and west. Even Earth's rotation plays a role. But much of a hurricane's movement is caused by changes in density. Particles in warm air have more energy than particles in cool air, so warm air is less dense than cool air. As a result, warm air rises. Since cool air is denser than warm air, cool air sinks.

In a hurricane, warm air continually moves up from the ocean's surface, and cool air continually moves down from high in the atmosphere. That's because as warm air rises, it cools and becomes more dense. Finally, the cooled air sinks back down. As it does, it becomes warmer and less dense. When it reaches the ocean's surface, the whole cycle begins again. At the same time, Earth's rotation causes the hurricane to move in a whirlpool pattern. In the center, or "eye," of the storm is an area of low pressure. The eye of a hurricane is quite calm, but the area immediately outside it is the most destructive part of any hurricane.

Hurricanes generally originate near the equator and over water. The ones that form in the Atlantic Ocean usually occur just north of the equator. Hurricanes in the Pacific Ocean can form to the north or south of the equator. No matter where they form, these storms are ranked in categories between 1 and 5. Category 1 is the least aggressive, and category 5 is the worst storm possible.

Category	Winds	Storm surge (ocean water pushed ahead of the hurricane by strong winds)
1	74–95 mph	4–5 ft
2	96–110 mph	6–8 ft
3	111–130 mph	9–12 ft
4	131–155 mph	13–18 ft
5	155+ mph	18+ ft

Eye: the center of the hurricane
Warmest air: the center of the hurricane
Cooler air: edge of the hurricane
Area of most destruction: area next to the eye
Area of least destruction: outer edges of the hurricane

Draw your own hurricane and label these parts:
1. Eye
2. Warm air
3. Cooler air
4. Area of most destruction
5. Area of least destruction (except the eye)

Briefly describe your hurricane. Include its category ranking, wind speeds, storm surge, and name. (There is a rule for naming hurricanes. Can you find out what it is?)
Answers will vary, but students should correctly identify the parts of a hurricane. Have students report on how hurricanes are named.

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Chapter 5

ENRICHMENT

Use with Section 3

• Chemical Energy

Enzymes and Nutrition

Enzymes, or biological catalysts, carry out chemical reactions in a much more efficient manner than chemical catalysts. Nearly every chemical process has its own specific enzyme. The human body contains thousands of enzymes to carry out life processes, including digestion, blood clotting, hormone production, and binding of oxygen to red blood cells. One method of increasing the rate of these and other chemical reactions is to increase the temperature. However, this is not practical for the biological systems of humans and other animals. Enzymes can speed up reactions without raising the temperature. How does this process work?

Substance #1 (undigested food, for example) contains a certain amount of energy. It requires additional energy to be transformed into substance #2 (such as chemical energy that the body's cells can use). As #1 proceeds with the transformation, it reaches its highest possible level of energy. At this point it's in the transition state, 1+. The physical structure of one particular digestive enzyme is a perfect match for the transition state 1+. The enzyme binds to the transition state and stabilizes it. After the transition state is formed, 1+ completes its conversion to substance #2.

The difference in energy between the substance and its transition state is called the activation energy. Enzymes reduce the activation energy by stabilizing the transition state. This allows more molecules of the substance to reach the transition state, which can then be converted into the new substance.

Metabolic enzymes are found throughout the body's blood, tissues, and organs. Digestive enzymes are secreted by the stomach, pancreas, small intestine, and other digestive organs. If a person lacks the ability to produce a certain digestive enzyme, she will be unable to convert specific foods into chemical energy that her body can use. The results of this may include malnutrition (not from lack of ingesting food, but from the inability to use it), bloating, and allergies. The production of enzymes is directed by a person's DNA. A genetic "mistake" or an inherited genetic condition may affect enzyme production.

Food enzymes are present in raw foods. They include protease to digest proteins, amylase to digest starch, lipase for fats, and cellulase to digest cellulose. These enzymes help us digest the foods that contain them. Cooking food at temperatures above 54°C, however, will destroy the enzymes. Microwaving food and irradiation can also harm enzymes. This is unavoidable in some situations. Meat and fish must be cooked thoroughly in order to kill disease-causing microbes. In order to digest cooked foods, the body's own enzymes must work extra hard. Nutritionists recommend that people eat a lot of fresh fruits and vegetables, not just for the nutrients, but also for the natural enzymes.

1. How do enzymes increase the efficiency of chemical reactions in the body?

Enzymes stabilize the transition state of a substance and lower the activation energy needed to convert the original substance to another one.

2. What are the three types of enzymes that the body uses and where are they found?

Metabolic enzymes, in the blood, tissues, and organs. Digestive enzymes in the digestive organs. Food enzymes in uncooked and unprocessed foods.

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Chapter 6

ENRICHMENT

Use with Section 1

• How does speed change?

The Art of Motion

Think back to the last time you read a comic book or saw a cartoon in the newspaper. Chances are that somewhere in that comic strip, the cartoonist showed a character in motion. Do you remember how it was done? Perhaps the cartoonist inserted horizontal lines to show motion. Maybe the cartoonist altered the actual shape of an object. List two or three techniques for showing motion in cartoons.

1. **Answers may include billowing clothing,**
2. **depicting two or more versions of the character in the same panel as, for instance, the character swings on a vine,**
3. **or over several panels showing people frozen in the background as the character races past.**

Using simple figures, motion lines, or other techniques, draw three cartoon panels of two automobiles on a highway. One is moving at a constant speed and one is accelerating.

Answers will vary. Panel 1 may present Car A behind Car B, in panel 2 they may be even, and in panel 3 Car A may be pulling ahead. Students may include long vertical motion lines to simulate speed. They may even change the shape of the car to show that one is "working harder" to pass the other.

What formulas did your cartoon illustrate?

The first, constant motion, represents the formula $speed = d / t$.

The second, accelerating motion, represents the formula $a = speed_{final} - speed_{start} / t$.

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Chapter 6

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Use with Section 2

• Why do things fall?

Mars Pathfinder: Coming in for a landing, and a landing, and a landing . . .

Launching the Mars Pathfinder in December, 1996, was one of the easier parts of that historic mission. The seven month journey to reach Mars progressed without any problems. Landing Pathfinder safely on Martian soil, however, required scientists to use some "low-tech" procedures that you might not associate with a complex space mission—a parachute and air bags.

The force of gravity on Mars is 3.7 m/s^2. Though that is less than one third that of Earth, it still exerts a significant pull on objects that enter its atmosphere. The logical solution to preventing Pathfinder from crashing onto Mars would seem to be a combination of rockets, engines, and braking mechanisms that would control the landing in a manner similar to that used for jet planes. But the scientists who built Pathfinder had a limited budget. All those rockets and engines would have been expensive to build and would have required large amounts of fuel.

So Pathfinder became the first "Martian skydiver." When it entered Mars' atmosphere, 130 km above the surface, it was traveling at 7400 m/s. At just over 9 km above the ground, a parachute opened and Pathfinder's speed gradually decreased to 370 m/s. As it continued to fall/float toward Mars, the lander that contained Pathfinder was lowered from the base of the parachute by a leash. Its speed continued to decrease, slowing to 67 m/s. Ten seconds before it landed, several airbags inflated and formed a protective shield around the lander. The leash was automatically cut 6.2 s later. When Pathfinder finally made contact with Mars, it was traveling at about 12.5 m/s. It landed, bounced about 15 m in the air, and then bounced 15 more times like a beach ball before it finally came to a stop about 1 km away. The entire bouncing sequence took about 2.5 min. The air bags were deflated and rolled up, the lander opened, and Pathfinder emerged.

Scientists still had to use some rockets to control the entry, but the parachute/air bag combination helped reduce the costs of the Pathfinder mission to one-fourteenth that of the Viking missions in 1976.

1. Would the same type (size, number) of parachutes and air bags have allowed Pathfinder to land gently on Earth? Why or why not?

 No. The force of gravity on Earth is much stronger than on Mars. Pathfinder's acceleration, due to gravity, would have been much greater. A larger or additional parachutes would have been needed to slow Pathfinder's entry on Earth as much as it was slowed down on Mars.

2. A force of 40 N is exerted on each of two objects, one on Mars and one on Earth. What is the mass of each object?

 40 N = m × (3.7 m/s^2),

 and 40 N ÷ 3.7 m/s^2 = 11 kg is the mass of the object on Mars.

 40 N ÷ 9.8 m/s^2 = 4 kg is the mass of the object on Earth.

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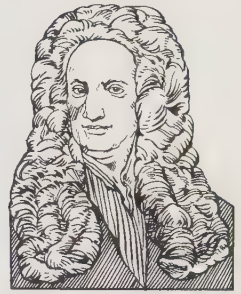
Chapter 6

ENRICHMENT

Use with Section 3

• How do things move?

Newton and His Forces



Sir Isaac Newton was born on Christmas day in 1642. In that same year, another famous scientist, Galileo, died. Together, Galileo and Newton's scientific ideas changed all of science. They ended traditions that dated back more than a thousand years, to the Greek philosopher Aristotle.

Aristotle believed that the natural state of any object was to be at rest. In addition, he said that an object would constantly work toward reaching that state. Both Galileo and Newton disagreed. Galileo developed idea that any object resisted any change in its motion. He called this phenomenon inertia. Newton went even further, saying that an object's motion would not change unless a force acted on it.

Newton's Three Laws

1. An object at rest will remain at rest, or an object moving in a straight line at constant speed will continue to do so until a force acts on it.
2. An object that has a force acting on it will accelerate in the direction of the force.
3. Forces always occur in equal but opposite pairs.

Apply what you've learned.

1. You are rolling a marble on the carpeting. Every time it comes to a stop you give it another push. Describe how Aristotle, Galileo, and Newton might explain what is happening to the marble as it slows and then stops.

 Aristotle: the marble's natural state is one of rest, so it works towards its natural state. Galileo and Newton: the carpeting is applying a force to the marble through friction, causing the marble to come to a stop.

2. You are a passenger in a car on a stormy and windy night. It is difficult to see because of the heavy rain. Suddenly the driver sees a fallen branch on the road and swerves to avoid it, and you are thrown against the car door so hard that it hurts. Later you discover a bruise on your arm. Why were you thrown against the door?

 Because of inertia your body was moving straight ahead. When the car changed direction, inertia caused you to bang into the door.

3. A meteor is headed directly from Mars to the sun. It approaches the moon, and slowly but surely its course changes, and it hits the moon's surface.

 a. In what direction was inertia carrying the meteor? **straight toward the sun**

 b. What force changed the course of the meteor? **the moon's gravity**

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Chapter 7

ENRICHMENT

Use with Section 1

• What is work?

Work, Work, and More Work

Classify the following as positive work (force and motion in the same direction), negative work (force and motion in opposite directions), or no work (no motion, or motion at right angles to the force).

1. carrying a suitcase **no work**
2. typing **positive work**
3. holding a bag of groceries **no work**
4. lifting an elevator **negative work**
5. upward part of a jump on a trampoline **negative work**
6. downward part of a jump on a trampoline **positive work**

Designing Your Own Experiment

Use the following materials to create an experiment or experiments that will demonstrate positive work, negative work, and no work at all.

ball(s)	string	book(s)
tape	board	object of your choice

Answer the following questions, using complete sentences.

1. Describe your experiment(s). Include exactly what was done to demonstrate positive work, negative work, and no work.
 Possible answers might include using the string to pull the book along a table (positive work), dangling the book on the string (no work), and pulling the book up off the floor (negative work).
2. In the space below sketch a picture of your experiment(s). Use arrows to indicate the direction of work. **Answers will vary.**

Bonus Question

Calculate the amount of work done in your experiment(s).

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Chapter 7

ENRICHMENT

Use with Section 2

• Simple Machines

Bicycle Gears

The first bicycles did not have multiple gears for ease of riding. Cyclists worked hard to cover ground. They sat over the front wheel because the pedals were attached directly to the wheel's axle. Rotating the pedals once around moved the front wheel only one complete revolution. The invention of the chain drive allowed the rider to sit in a safer, more balanced position between the front and back wheels.

Chain drives transfer the power from the rider's legs, which push down on the pedals attached to levers (the cranks), which turn the axle of the toothed wheel (front sprocket, or chain ring). The chain is a continuous loop attached to the chain ring and a rear sprocket. As the chain ring rotates, it moves the chain, which moves the rear sprocket, which turns the rear wheel's axle. Thus, the invention of the chain drive meant that a rider propelled the bike forward by moving the rear wheel, not the front one. If you think chain drives resemble pulley systems, you're right!

Later, the addition of gears with varying ratios made it easier to ride up steep inclines and pedal more efficiently. Gear ratios are figured by dividing the number of teeth in the front sprocket by the number of teeth in the rear sprocket. If there are 54 teeth in front and 27 in back, the ratio is 2 to 1 because $54 \div 27 = 2$. This means that the rear sprocket goes around twice each time the rider moves the chain ring one complete revolution. If the rear sprocket has 13 teeth, the ratio is about 4 to 1. One turn of the pedals will rotate the back sprocket four times. On downhills or level ground, a rider doesn't have to work as hard to move the bicycle in the "fourth" gear as in the "second."

On the other hand, the steeper the incline, the more difficult it is to ride a bike in a high gear (think of lifting a heavy object straight up instead of pushing it along a ramp). In this case the rider's goal is to easily turn the pedals several times before the rear sprocket completes a revolution. The rider needs to shift into a lower gear.

1. Complete the table below by computing the gear ratios (round to the nearest whole number).
2. Which gear would be best for riding up a steep hill?
 Gear d has the lowest ratio. It would be the best gear for riding uphill.

Gear	Number of teeth in rear sprocket	Number of teeth in front sprocket	Gear ratio
a	11	60	**5:1**
b	22	54	**2:1**
c	41	84	**2:1**
d	60	54	**1:1**

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Chapter 8

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Use with Section 1

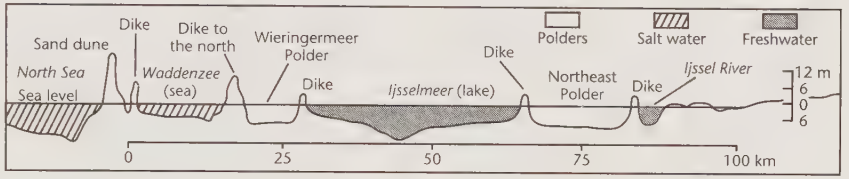
• Landforms

Building New Landforms

People have always changed the land to create more space. San Francisco, New York City, and Boston are examples of places where people have filled in bays with soil to extend their land area. Japan and Hong Kong have built airports in their bays.

One of the best known examples of extending a coastal plain is the Netherlands. Over the centuries, the Dutch have built polders, or tracts of lowland reclaimed from the sea, lakes, or marshes. First dikes of sand and large rocks are built. Then the polder area is pumped dry. In years past, the windmills that dot the Netherlands provided the power needed to pump the sea water out. Now, electrical pumps do the work. The dikes have long been used to keep the sea from flooding the polders and the rest of their land.

The Netherlands occupies a small area of land, and more than 15 million Dutch live there, so the population density is 421 people per square kilometer. (The United States population density is 29 people per square kilometer.) The Dutch need and use every bit of land they have. They even use median strips of highways for crops. In the Netherlands, the largest cities and richest farmland are found on the polders.



Today, the dikes and polders in the Netherlands face several threats. One problem is caused by a seemingly unlikely hazard—muskrats. These rodents tunnel beneath the dikes and can cause a dike to collapse at any time. It takes only a few muskrats to destroy a dike. And the Dutch estimate they have millions of muskrats. With half of their country lying below sea level, the Dutch take the muskrats seriously—they have hundreds of workers whose jobs are to trap the muskrats.

The Dutch also worry that global warming might harm their system of dikes and polders. During a warm winter in 1995, the snow from the Alps melted quickly. This caused the rivers that flow through the Netherlands on their way to the sea to flood. Although the dikes held, about 250 000 people had to leave their homes until the floodwaters receded.

If Earth does grow warmer, more floods will probably occur. After the 1995 flood, the Dutch began a huge project to strengthen the 750 km of dikes. They are also building new kinds of dams. These have sluices, or gates, in them that can be opened or closed as needed. The Dutch hope to direct the floodwaters into open fields rather than toward towns and cities. The Dutch face a huge task, but they have worked for centuries to protect their land. They are confident they will continue to succeed.

Study the diagram that shows a side view of the elevation of the polders. Then answer the questions.

1. From the diagram, what is the approximate elevation of the Wieringermeer and Northeast polders?
four to six meters below sea level

2. Along the cross section in the diagram, about how much land is above sea level?
probably less than 20 km

3. Why must the Dutch continue to strengthen the dikes and build new dams?
Answers will vary but should point out that failing to do so could cost lives and property; with the country so crowded, the Dutch must "create" new land to grow.

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Chapter 8

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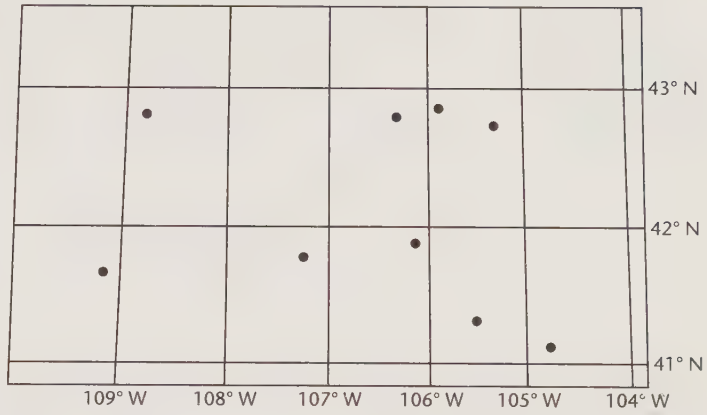
Use with Section 2

• Viewpoints

Degrees and Minutes

Each degree of latitude or longitude may be divided into **minutes.** There are 60 minutes in a degree. A minute may be written with the symbol '. For example, a location identified as 30° 30'E is thirty degrees and thirty minutes east of the prime meridian.

Use the map of part of Wyoming to complete the items below.



1. Place the letter of each city next to its location on the map.

City	Location	City	Location
A. Casper	42° 52'N; 106° 20'W	F. Glenrock	42° 53'N; 105° 55'W
B. Cheyenne	41° 9'N; 104° 49'W	G. Rock Springs	41° 40'N; 109° 10'W
C. Laramie	41° 20'N; 105° 30'W	H. Rawlins	41° 50'N; 107° 20'W
D. Douglas	42° 45'N; 105° 20'W	I. Lander	42° 50'N; 108° 49'W
E. Medicine Bow	41° 56'N; 106° 11'W		

2. Which cities would have overlapped if the locations had been rounded to the nearest degree only? **Casper and Glenrock**

3. The grid of imaginary lines can also be broken down more precisely by using seconds in addition to degrees and minutes. Sixty seconds make up 1 minute. Under what conditions would seconds be needed? **in navigation, in building roads, and on large-scale maps**

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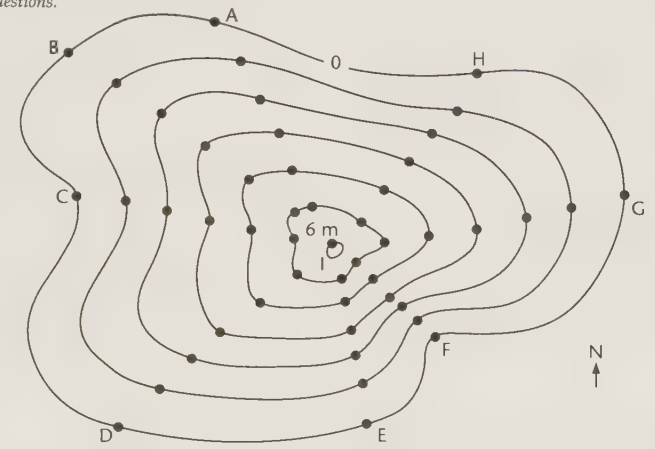
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Use with Section 3

• Maps

Creating a Topographic Map

The map below represents an island off the eastern coast of the United States. The contour lines on the map show sea level and the highest point on the island. Construct additional contour lines according to the following steps, then answer the questions.



A. Divide the distance from point A to point I, the highest point of elevation, into 6 equal distances. One section equals a 1-meter interval. Place a dot at each division.

B. Continue Step A for points B–H.

C. Connect the dots for each contour line, following the shape of the coastline.

1. Between which point on the coast and point I is the slope the most gentle? What evidence supports your conclusion? **Point B, because the contour lines are farthest apart along that slope.**

2. Do you see any evidence that a stream flows from point I to any point along the coast? Explain your answer. **No, the contour lines between points I and other points would have Vs showing the presence of a stream.**

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Chapter 9

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Use with Section 1

• Minerals

Minerals Commonly Found in the Home

Materials

5 ordinary objects made from minerals
pen or pencil

Procedure

1. Collect five examples of items commonly found in the home that are made from minerals. The following list will provide you with some examples: salt, pencil, sandpaper, talcum powder, jewelry, plaster.
2. List the five items in the table below.
3. Write the name(s) of the minerals each item contains.
4. If you have difficulty finding five items, study the "Uses" column of Appendices M and N of your textbook.

Analyze

Item	Minerals
1.	
2.	
3.	
4.	
5.	

Conclude and Apply

Use your textbook to help answer these questions.

1. What is the name of the most common group of minerals? **silicates**
 Do you have any examples of this group? What are they? **Answers will vary.**

2. What mineral group contains limestone, dolomite, and marble? **carbonates**
 Do you have any examples of this group? What are they? **Answers will vary.**

3. What is the most common carbonate mineral? **calcite**
 Do you have an example of this mineral? What is it? **Answers will vary.**

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Chapter 9

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Use with Section 2

• Mineral Identification

Halides

Use the table below to help answer Questions 1–4.

The **halides** form a small group of minerals. Minerals in this group differ in many ways from each other, but are similar in composition. Halides are soft minerals, and most are water-soluble. The chart shows some properties of the two most common halides.

Characteristic	Halite	Fluorite	Any other halide
Composition	sodium and chlorine	calcium and fluorine	**Answers will vary.**
Location	dried lakes, rock layers	rock layers	
Occurrence	worldwide in dry areas	common vein mineral	
Crystal	cubic	cubic	
Color	colorless or light	most colors	
Hardness	2.5	4.0	
Luster	glassy	glassy	
Other properties	brittle, transparent, sometimes flourescent, water soluble	brittle, transparent, often flourescent	

Less common halides and their composition include:
- sylvite (potassium and chlorine)
- sal ammonica (aluminum and chlorine)
- cerargyrite (silver and chlorine)
- bromyrite (silver and bromine)
- calomel (mercury and chlorine)
- atacamite (copper and chlorine)
- cryolite (sodium, aluminum, and fluorine)

1. Describe similarities in the physical properties of halite and fluorite. **Their crystals are cubic. Both are soft; their luster is glassy; and they are brittle, transparent, sometimes fluorescent.**

2. Most halides are water-soluble. Why do you think minerals that are highly water-soluble are difficult to find in large deposits or are found only in dry regions? **Water in the ground will carry soluble minerals with it.**

3. The halides listed above include sodium, calcium, potassium, aluminum, mercury, silver, or copper in their composition. Tell how these compounds are alike. Then write a definition of halides based on the elements that make up their composition. **Sodium, calcium, potassium, mercury, silver, and copper are metals. Halides are compounds of a metal and fluorine, chlorine, or bromine. (Some unlisted halides include iodine.)**

4. Research a third halide. Add its characteristic to the chart.

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Chapter 9

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Use with Section 3

• Uses of Minerals

Gold!

Use information from the paragraphs below and from library references to answer Questions 1–4.

Gold was among the earliest metals discovered. It occurs in octahedral crystals, but is also found as flakes, thin wires, and veins. From the beginning, it was prized for its beauty and its rarity and came to be a sign of wealth. It was used to make coins and bars which, like money today, could be used to buy things.

The ancient Egyptians were among the earliest peoples to develop goldsmithing as an art, making jewelry and other beautiful objects from the metal. They used solid gold, beating and pounding it to the shape they wanted. Gold is easily worked, since it has a hardness of only 2.5.

Early in America, gold was mined for decorative uses. The Inca writer Garcilaso de la Vega, writing in the early 17th century, described the Temple of the Sun at Cusco: "The four walls were hung with plaques of gold, from top to bottom, and a likeness of the Sun topped the high altar. This likeness was made of a gold plaque twice as thick as those that paneled the walls . . . the whole thing was so immense that it occupied the entire back of the temple. . . ."

Gold can be found in most parts of the world, but it often is difficult to separate it from the other minerals, usually quartz, where it is found. Frequently a ton or more of rock will yield only a few dollars' worth of pure gold. Some gold on Earth's surface is found in the slow-flowing parts of rivers. Uncovered by erosion, gold is washed downhill by rapidly moving water and runs into rivers. The gold drops out of the river water because of its heavy weight. This forms piles of gold called placer deposits. It was this visible gold that began the famous gold rushes in the western United States and in Australia. When gold is found in quartz veins, it is separated by crushing ore and obtaining a concentrate to be smelted (melted and separated).

Gold is still used for jewelry and other art objects. Today, however, other metals, such as copper or silver, usually are added to gold to make it harder and more durable. More recent markets for gold include dentistry and electronics. Strangely, most of the gold that is dug out of rocks ends up underground again—in bank vaults where it is stored by governments and investors!

1. How have the hardness and luster of gold made it an important metal? **Its luster makes it desirable for ornamentation; its softness makes it easy to work with.**

2. Explain how the weight of gold affected the history of some western states. **The weight of gold caused it to sink in slow-running water. These placer deposits were easily seen and began several gold rushes, settling parts of the west.**

3. Why is gold expensive? **Gold is difficult to find and very much in demand.**

4. The Spanish came to America from Europe in the 16th century. Use a history of Mexico or Peru to find out how the presence of gold affected the lives of Native Americans in Mexico or Peru during the 16th and 17th centuries. **Answers should include the fact that Europeans conquered many peoples in order to take their gold.**

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Chapter 10

ENRICHMENT

Use with Section 1

• The Rock Cycle

Analyzing Rocks

Materials

paper and pencil
goggles
metric ruler
rock hammer
streak plate
rock samples
hand lens
glass slide
steel file
towel

Procedure

1. On a piece of paper, copy the table heading shown in "Data and Observations." Make your table ten rows long to provide space for recording information about the ten rock samples.
2. Examine the rock samples. Observe characteristics such as minerals present, the size and shape of mineral grains, and the arrangement of grains. Record your observations in the table you make. An example of what you might observe has been done for you in "Data and Observations."
3. Group all the rocks that have a common characteristic. Make at least three categories. In the last column of the table, record the common characteristics on which you based your groupings.
4. Compare your system of classification with those devised by your classmates.
5. Crush bits of the rocks. **CAUTION:** *Wrap rock samples in a towel before hitting them with the hammer. Always wear goggles when using a rock hammer.*
6. Examine the crushed samples with the hand lens. Record any observable characteristics not seen in the larger specimen.

Data and Observations

Sample	Minerals present	Size/Shape of minerals	Arrangement of grains	Other information	Common characteristic
1	Quartz Feldspar Diorite	0.5 cm, rectangular			grain size similar to samples 3 and 7

Analyze and Conclude

1. Was there any characteristic common to all rock samples? **Students may say that all the rocks were hard or that they all contained minerals.**
2. What feature was most useful in grouping the rocks? **texture**
3. What feature was least helpful in grouping the rocks? **color or size**
4. Was there a characteristic observed in the crushed rocks that aided or changed your system of grouping? Explain. **mineral composition**
5. Was your system of grouping different from those of your classmates? Why might different classification systems be devised? **Answers will vary. Some people observe different characteristics than others. A special-purpose system might be devised, such as one in which texture is more important than mineral in a composition.**

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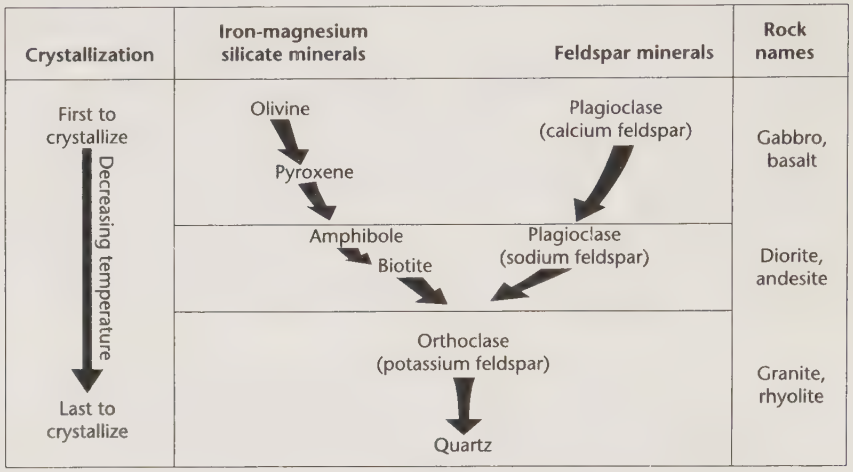
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Use with Section 2

• Igneous Rocks

Crystallization

This chart represents the order in which different minerals crystallize from a cooling magma or lava to form igneous rocks. Both mineral names and the rocks they form are shown. Use the chart to answer the questions.



1. Which minerals are the first to crystallize from cooling magma? **olivine, plagioclase (calcium feldspar)**
2. What kind of rocks are formed by these minerals? **gabbro, basalt**
3. Which mineral crystallizes at the lowest temperature? **quartz**
4. Which mineral, pyroxene or orthoclase, crystallizes from magma first? **pyroxene**
5. Which feldspar mineral is found in granite? **orthoclase**
6. What minerals form the rocks diorite and andesite? **amphibole, biotite, plagioclase**
7. Minerals higher in silica content crystallize from magma at lower temperatures. Which magma, basaltic or granitic, is higher in silica content? **granitic**
8. Magma low in silica content flows more easily. Which kind of lava, basaltic lava or granitic, flows faster? **basaltic lava**

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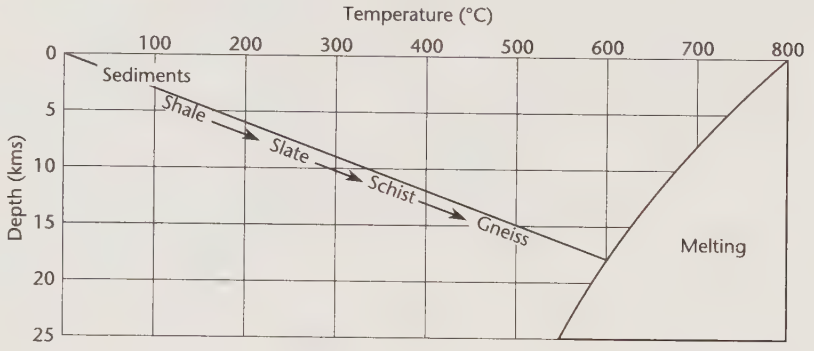
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Use with Section 3

• Metamorphic Rocks

Metamorphic Process

Use the graph to answer questions about the formation of metamorphic rocks.



1. What is the relationship between rock temperature and depth beneath the surface?
Temperature increases with depth.

2. At a depth of 10 kilometers, what would the temperature be? **250°C**

3. Between 0 and 10 kilometers, how many degrees per kilometer does the temperature increase?

$$10\text{ km}\overline{)250°\text{C}}^{\,25°\text{C/km}} \quad \text{or} \quad \frac{250°\text{C}}{10\text{ km}} = 25°\text{C/km}$$

4. Which metamorphic rock shown forms at the highest temperature? **gneiss**

5. Through what general temperature range would you expect schist to form? **300°C–400°C**

6. How many kilometers beneath the surface does gneiss occur? **17–22 km**

7. As the depth increases, what happens to the temperature at which rock melts? **Melting temperatures decrease.**

8. Suppose you knew that a certain metamorphic rock begins to form at about 300°C. How many kilometers beneath the surface might this rock temperature occur? **12 km**

9. How far beneath the surface does shale metamorphose to slate? **6–8 km**

10. Metasomatism is described as a process by which metamorphic rocks may gradually change into granite (an igneous rock). At which temperature does metasomatism begin? **500°C–600°C**

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Chapter 10

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Use with Section 4

• Sedimentary Rocks

Analyzing Sedimentary Rocks

Materials

- flat pan or shallow dish
- spoon
- table salt
- water

Procedure

1. Place about 3 centimeters of water in the pan or shallow dish.
2. Gradually add table salt to the water as you stir it gently.
3. Continue adding salt until no more can be dissolved in the water.
4. Stir the solution thoroughly.
5. Observe and note the appearance of the pan and its contents.
6. Place the pan with its contents on a windowsill or countertop where it will not be disturbed.
7. Once each morning and evening, observe the pan and record what you see.
8. Continue this process until all the water has evaporated.
9. Once all the water has evaporated, observe and record the appearance of the pan.

Analyze

1. What did you observe in the pan as the days passed and on the final day of this activity?
Answers will vary, but may include that as the days passed, the water level decreased and crystals began forming on the sides of the pan. After all the water had evaporated, a layer of salt crystals formed on the bottom of the pan.

2. What caused the salt deposition in the pan? **The water evaporated and the salt that was in solution settled out and was deposited on the bottom of the pan.**

Conclude and Apply

3. How does what you observed in the pan help explain sedimentary rock formation? **The processes observed in the pan are the same processes that occur any time water with a substance in solution evaporates.**

4. Sedimentary rocks formed by deposition of minerals when water evaporates are called evaporites. Name a common evaporite mineral or rock. **halite/rock salt**

5. Deposition of evaporite sedimentary rocks occurred in the Dead Sea flats and the Bonneville salt flats. Explain what might have happened to cause the evaporite deposits. **A large saltwater sea evaporated, causing the salt in solution to be deposited.**

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Chapter 11

ENRICHMENT

Use with Section 1

• Energy Resources

The Greenhouse Effect and Global Warming

Did you ever get into a car that had its windows closed on a sunny day? You probably jumped out quickly because the inside of the car and the car's interior was very hot. As sunlight passed through the windows, the car's interior absorbed and radiated heat energy. This process is called the greenhouse effect.

The greenhouse effect also happens in Earth's atmosphere. Gases called greenhouse gases—which include carbon dioxide, methane, and nitrous oxide—are found in the atmosphere. These gases naturally absorb heat energy from the sun. This absorbed heat warms the atmosphere, the oceans, and the land. However, increasing amounts of greenhouse gases are being produced, particularly by the burning of fossil fuels. This increase has made the atmosphere absorb more and more radiation.

Scientists are concerned that these increased concentrations of greenhouse gases could cause atmospheric temperatures to rise worldwide. This is known as global warming.

A rapid global warming trend could have devastating effects on the environment. Rainfall patterns could change, affecting the types and amount of plant life in many areas. Global warming could make present farmlands too dry to grow crops. An increase in atmospheric temperature of only a few degrees could cause polar ice caps to melt and sea level to rise, resulting in flooding in many coastal areas.

Answer the following questions, using complete sentences.

1. The absorption of energy from the sun by greenhouse gases is necessary for life on Earth. Without it the average yearly temperature of Earth's surface would be about –25°C! So why are scientists concerned about greenhouse gases?

 Answers will vary, but should include the fact that high levels of greenhouse gases cause global warming—too much radiation from the sun is absorbed and the atmospheric temperature rises.

2. Unlike many pollutants, which affect small regions, global warming affects people worldwide. How do you think the world should approach this problem?

 Answers will vary, but students will probably say that all countries that are able should have a part in trying to find a solution to the problem of global warming.

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Chapter 11

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Use with Section 2

• Alternative Energy Resources

Tidal Power

Tidal power is a source of energy that could play an important role in generating electric power during the coming years. Tides are the rhythmic rise and fall of the ocean's surface caused by the gravitational pull on the water by the moon and, to a lesser extent, the sun. This back and forth flow of ocean waters can provide a source of energy that does not pollute and will never run out.

Tidal energy can be used wherever there are high tides in a bay that is narrow enough to be enclosed by a dam. During high tide, the bay fills with water. During low tide, the level of the ocean drops below the level of the water stored behind the dam. The stored water is then released. As the water falls, it drives turbines that generate electricity.

The first and largest tidal power plant in the world began to operate in France in 1966. A dam equipped with reversible turbines permits the tidal flow to work in both directions—from the sea to the tidal basin on the incoming tide and from the basin to the sea on the outgoing tide. Russia also has several tidal power plants.

Some disadvantages to tidal power plants include their expense to build and maintain. Also, tidal power plants are not always able to provide energy when it is needed. The amount of energy generated varies according to time of day and with the seasons.

1. List some advantages to using tidal power.

 Answers will vary, but students will probably mention some of the following points. Tidal power does not pollute and will not run out. Large amounts of energy are available from the tides.

2. List some disadvantages to using tidal power in addition to those mentioned above.

 Answers will vary, but students may mention that only certain sites can be used for tidal power generation: bays that are naturally adapted to the building of a dam. Students might also note that tidal power plants might disturb or destroy ocean habitats.

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Chapter 11

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Use with Section 3

• Water

The Effect of Pollution on the Life Cycle of a Lake



Runoff from sewage, industrial waste, and fertilizers drains into the lake. The lake becomes clogged by an overgrowth of plants and algae. Fish die from lack of oxygen.

Lakes and ponds go through definite life cycles. When a lake first forms, it contains pure freshwater and little life. Plants and animals begin to live in the lake as it grows older. The organic matter from the plants and animals provides nutrients for other life to grow. A healthy lake has a balance of nutrients and organisms.

Throughout its life cycle, a lake naturally becomes smaller as sediments and decayed plants fill its bottom. Plants grow in from the edges, eventually filling the lake. After a length of time—ranging from a few decades to several thousands of years—the lake disappears.

However, this process is greatly accelerated by runoff containing sewage, industrial waste, and fertilizers feeding into a lake. The lake becomes clogged by plants and algae that feed on the nutrients in these pollutants. When the plants and algae die, bacteria in the lake use oxygen to break them down. The more plants that grow, the more that die, resulting in more bacteria and less oxygen. Fish and other organisms eventually die from this lack of oxygen. The lake dies due to the effects of the pollution.

1. How are lakes affected by pollution?

Answers will vary, but students will probably mention some of the following points. Sewage, industrial waste, and fertilizers contain nutrients that cause the number of plants in the lake to increase. Increased plant growth causes an increase in bacteria, which reduce the amount of oxygen in the water, causing fish and other organisms to die.

2. If lakes are already going to disappear when their life cycle is complete anyway, why is pollution such a problem?

Answers will vary, but students will probably state that pollution causes the lakes to die prematurely and takes away the chance for species to live and evolve in a healthy environment.

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Chapter 11

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Use with Section 4

• Land

Saving the Wetlands

A wetland is an area that is covered with shallow water or that has wet soils. Wetlands include swamps, marshes, fens, and bogs. Wetlands are home to a variety of plant and animal life and exist throughout the world.

For many years, people thought that wetlands were useless. For this reason, more than 35 percent of the wetlands in the United States had been drained and destroyed by the 1970s. Wetlands were drained or filled in to make way for houses, shopping malls, and other developments. However, since the early 1970s, there has been an increasing awareness of the ecological value of wetlands.

Wetlands help to minimize flooding because they absorb excess water and release it slowly, making flooding less likely. In addition, wetlands store large amounts of water for long periods.

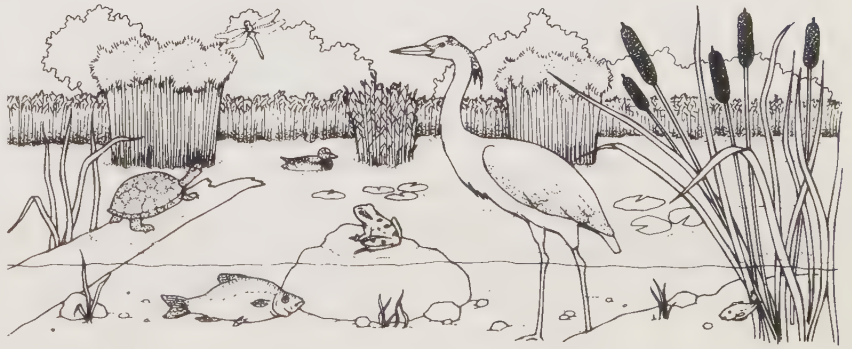
Wetlands also provide rich environments for wildlife. Mammals such as moose, muskrats, and mink find food and shelter in the wetlands. Numerous varieties of birds make their homes there as well. Coastal wetlands are the breeding grounds for many species of fish and crustaceans. Many states have enacted laws to protect wetlands.

1. What are the two main purposes of wetlands?

Wetlands help prevent flooding by absorbing excess water and releasing it slowly. They also provide natural habitats for wildlife.

2. How do you think our environment would be different if our ancestors had not destroyed so many of the wetlands in the past?

Answers will vary, but students will probably state that we probably would not have as much trouble with flooding and there would be more species and larger populations of wildlife whose natural habitat is the wetland.



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Chapter 12

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Use with Section 1

• Earth's Atmosphere

Observing the Effects of Air Pressure

The activity at the beginning of the chapter showed how temperature affects the density of air. When the air in a can became heated by boiling water, it expanded and much of it escaped out of the can before the top was put on. As the air that was left inside cooled, it became denser and took up less space. Because the air pressure on the outside of the can was higher than the pressure inside the can, the sides of the can collapsed. You could see what a powerful force air pressure can be. Here's another experiment about the power of air pressure.

Materials

glass bottle
sheet of paper
long match or paper drinking straw and match
hard-boiled egg, peeled

Procedure

1. Be sure that the opening at the top of the glass bottle is slightly smaller than the diameter of the egg.
2. Crumple the sheet of paper into a ball and drop it into the bottle.
3. Light the end of the paper drinking straw or the long match. Put the paper, burning end first, in the bottle. Be careful!
4. Let the paper burn until the flame burns out.
5. Set the peeled hard-boiled egg over the opening at the top of the bottle with the pointed end of the egg down.

Analyze

1. What happened to the egg? **It was sucked into the bottle.**
2. What caused the egg to do this? **The burning paper burned up the available oxygen in the bottle and the heat made the molecules in the remaining air move farther apart or become less dense. The air pressure on the inside of the bottle became lower than the air pressure on the outside. The outside air pressure pushed the egg into the bottle.**

Conclude and Apply

3. How can you get the egg out? **Increase the air pressure inside of the bottle. Hold the bottle upside down at an angle with the egg's small end over the opening. Blow hard into the bottle. This should increase the air pressure. Quickly turn the bottle completely upside down with the egg over the opening. If you increase the air pressure enough, the egg will be pushed out.**

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Chapter 12

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Use with Section 2

• Energy from the Sun

Determining Temperature Change

Do the activity below to observe the different ways heat energy can be transfered.

Materials

dark-colored, small block of wood
thermometer
water
electric teapot or teapot and hot plate
coffee mug
ice cubes
room heater or register
clock or watch

Procedure

1. Place a wooden block in direct sunlight and record its temperature.
2. Measure and record the temperature of the block after two hours in the sun.
3. Heat water in the teapot and pour it into the mug. Record the temperature of the water.
4. Place two ice cubes in the water. After 10 minutes, measure and record the temperature of the water.
5. Record the temperature of the air as shown on the thermostat.
6. Ask an adult to turn up the thermostat.
7. Stand near the room heater or register, then stand near the cold air return. Record your observations.
8. After 20 minutes, again record the temperature shown on the thermostat.

Analyze and Conclude

1. What happened to the wood block? **It warmed up after being in direct sunlight.**
2. What type of heat transfer caused what you noticed? **Heat transfer was by radiation from the sun to the wood block.**
3. What happened to the temperature of the water when ice cubes were added? **The temperature decreased.**
4. Explain the method of heat transfer demonstrated by the ice in the water. **Heat transfer was by conduction. Heat was transfered from the fast-moving molecules of the hot water to the slow-moving molecules of the ice. The molecules try to reach the same speed in both the water and the ice.**
5. Explain what happened in the room when the thermostat was turned up. **Hot air came out of the register and cooler air was pulled into the cold air return. The circulation of air set up a current of rising hot air that cooled and sank toward the cold air return.**
6. Which method of heat transfer is demonstrated by the heating of the room? **convection**

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Chapter 12

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Use with Section 3

• Movement of Air

Thermals

Convection is responsible not only for major wind systems that affect the entire Earth but also for small-scale air movements that affect only a small part of Earth's surface. Land and sea breezes are an example of small-scale air movements, or local winds. These small-scale movements are the result of differences in temperature over land and sea.

Thermals are another type of small-scale movement. Thermals develop only over a few hundred square meters of land and last less than an hour. The formation of thermals is described in the following pictures.



FIGURE 1



FIGURE 2



FIGURE 3

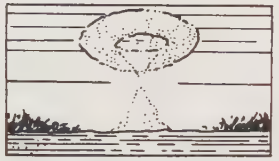


FIGURE 4



FIGURE 5

Figure 1 shows the thermal beginning as a rising column of air at Earth's surface. In Figure 2, a cap develops at the top. Eventually, the cap breaks off and increases in size as it continues to be forced up (Figures 3 and 4). At higher altitudes, the thermal develops a "donut-shape" before it dissipates in the cooler air (Figure 5).

Thermals may develop where Earth's surface is warm and the overlying air is cool. This may occur anywhere on Earth. The amount of heating at the surface varies, depending upon the amount of solar radiation absorbed by that part of Earth's surface.

1. Thermals occur as a result of hot and cold air movements: **warm** air rises and **cold** air sinks.

2. What eventually causes a thermal to dissipate? **contact with cool air**

3. Vultures and hawks sometimes "glide the thermals." What do you think this means? Why do you think they do it? **It means they use the hot air currents to move instead of using their wings. They do it to save energy.**

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Chapter 13

ENRICHMENT

Use with Section 1

• What is weather?

Relating Clouds to Weather

Clues to predicting the weather can include observations of cloud types.

Materials

camera **CAUTION:** *Do not aim the camera directly at the sun. Damage could occur to the eyes if direct sunlight is observed.*
roll of film
pencil and paper

Procedure

1. Take photographs of the sky during the day for seven days.
2. Record the weather conditions and time of day when each photograph is taken.
3. Watch or listen to a nightly weather report and briefly record what conditions existed that day.
4. Make a table of your data.
5. Use your textbook, cloud charts, and weather forecasts to identify the type or types of clouds in each photograph.
6. Look up the weather conditions that each cloud type in your photographs should have associated with it. Compare this information with your observations.

Analyze

1. List the types of clouds you observed and the weather conditions you noted that were associated with each type. Not all types may have been observed. **cumulus—fair weather, partly sunny; cirrus—thin, white, feathery; stratus—low, gray, steady, thick cover; nimbus—dark gray with irregular edges**

2. Write a description of each cloud type you observed. **cumulus—billowy, looks like big white pillows; cirrus—fair weather but forecast calls for rain; stratus—light rain, gray skies; nimbus—steady rain**

3. Do you notice any pattern to the clouds observed and the weather experienced? Explain. **Yes, the darker, heavier clouds are associated with drizzle, rain, and snow.**

Conclude and Apply

4. What occurs when a stratus cloud forms close to the ground? **fog**

5. Did you observe fog? What were the temperature and moisture conditions? **Fog occurs when warm, very moist layers of air flow across a cold surface.**

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Chapter 13

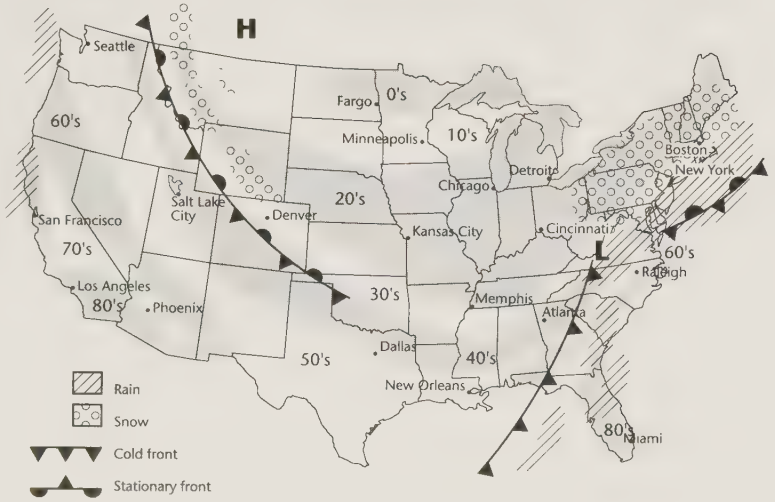
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Use with Section 2

• Weather Patterns

Reading Weather Maps

The symbols on the weather map below show the locations of fronts, high- and low-pressure areas, and different kinds of precipitation across the United States at 2:00 in the afternoon on a particular day in March. Shaded bands on the map indicate areas that have about the same temperature. The key below the map tells what the symbols mean.



Answer the questions below based on information in the weather map.

1. Would you expect to find clear weather or clouds near Fargo, North Dakota? **Fargo is near a high-pressure area and it is not near any of the fronts, so you would expect clear weather there.**

2. Where would you expect to find a storm? **Along the fronts on the East Coast of the United States, especially closest to the center of the low-pressure area.**

3. How is the weather in Salt Lake City, west of the stationary front, different from the weather in Denver, east of the front? **The temperature in Salt Lake City is in the 50s. The temperature in Denver, on the other side of the front, is in the 30s. (Temperatures on this map are given in degrees Fahrenheit.)**

4. What is happening to the air masses at the cold front? **Cold air pushes under a warm air mass and forces it to rise. Storms and clouds form along the front.**

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Chapter 13

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Use with Section 3

• Forecasting Weather

Making Forecasts

Materials

Celsius thermometer
magnetic compass
aneroid barometer

Procedure

1. Make a chart like the one shown below to record your weather observations each day for 7 days. Be sure to make observations at the same time and place each day.
2. Determine the temperature by placing the thermometer in a shaded location.
3. Determine the air pressure using the aneroid barometer.
4. Estimate the amount of sky covered by clouds as clear, overcast, or somewhere in between.
5. Determine the types of clouds using Field Guide to Clouds in your textbook.
6. Use a compass to determine the direction from which the wind is blowing.
7. Describe the precipitation. Use the terms *rain, snow, sleet, hail, fog,* or *clear.*
8. Use the data you collect each day to forecast weather conditions for the following day. Note any trends you see in your observations, such as high cirrus clouds preceding rainy weather.

Date	Temperature (°C)	Atmospheric pressure	% Cloud cover	Cloud types	Wind direction	Precipitation	Forecast

Conclude and Apply

1. Was there a relationship between low barometric pressure and the presence of clouds and precipitation? Explain. **Yes, low barometric pressure is associated with clouds because a low pressure area pulls in moisture-laden air from surrounding locations.**

2. How accurate were your forecasts for the next day? Give an explanation for any errors that may have occurred in your forecasting. **Students may suggest that moving fronts became stationary, lower humidity than expected prevented the development of rain, and so on.**

3. What weather observations can you make yourself? **temperature, atmospheric pressure, percent cloud cover, cloud types, wind direction, precipitation**

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Chapter 14

ENRICHMENT

Use with Section 1

• What is climate?

Compare the Climate

You know that latitude is one of the most important factors that affects climate. The tropical climate in places near the equator is very different from the temperate climate of the United States.

Most places near the equator have about the same weather all year. Warm, moist air masses bring hot weather, high humidity, and daily rains to these tropical areas. Temperatures hardly vary from the average of 26°C. Annual rainfall is usually at least 150 centimeters. A great variety of trees grow in the wet conditions of the tropical rain forests. Many grow as tall as 60 meters and form a dense canopy. The ground is dark and shady with little undergrowth. Dense impenetrable jungle with thick undergrowth is found only along riverbanks and other places where the sun reaches. Vast areas of rain forests have been cleared for timber, agriculture, and mining.

The temperate climate is typical of many parts of the United States. It includes a wider variety of conditions than the tropical climate does. The weather can change every day as winds carry a series of low-pressure and high-pressure systems through an area. Generally, low-pressure systems bring wet weather, and high-pressure systems bring clear weather. Temperate climates have winters one to five months long in which plants are dormant. Winter temperatures are below 6°C, the temperature needed for plants to grow. Temperate regions cover only 7 percent of the world's land, but more than 40 percent of Earth's people live in them.

In each space below, identify which climate is being described. Explain your answer using the information provided above.

1. It rains hard here every afternoon. **Tropical climate: most areas have daily rains.**

2. There are no leaves on the trees and the plants in the garden look dead. **Temperate climate: winter temperatures are below the temperature that plants need to grow.**

3. If you don't like the weather, wait a day or two and it will change. **Temperate climate: a series of high- and low-pressure systems bring changeable weather.**

4. There is a greater variety of plants growing here naturally than anywhere else. **Tropical climate: the wet conditions and steady temperatures encourage varied plant life.**

5. This climate is always the same. **Tropical climate: temperature is about the same all year and it rains every day.**

6. High- and low-pressure systems follow each other throughout the year. **Temperate: winds carry a series of low-pressure and high-pressure systems through an area.**

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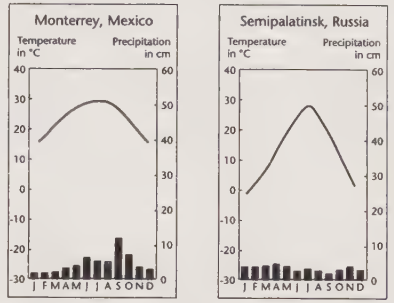
Use with Section 2

• Climate Types

The Steppe Climate

The steppe or semiarid climate zone is located in prairies and grasslands. Steppes are often found surrounding desert areas. Annual rainfall is light, somewhere between the desert and more humid climates. Specific characteristics of steppes depend on their latitude and whether they are located near mountains and oceans.

The graphs below show one way to summarize basic climate information. The line shows how the temperature changes over the year. The bar graphs show the monthly precipitation (J is for January, F is for February, and so on.). Both places graphed are classified as steppes.



Use the information in the graphs to answer the questions.

1. How is the rainfall distribution different between the two places? **In Monterrey, Mexico, the rainfall is higher in summer. In Semipalatinsk, Russia, rainfall is higher in winter. Students may also note that Semipalatinsk has a more even distribution of rain than Monterrey.**
2. What does the graph tell you about the temperature range in Monterrey? **The highest temperature is about 30°C and the lowest is about 15°C. The range is about 15°C.**
3. What does the graph tell you about the temperature range in Semipalatinsk? **The highest temperature is about 30°C and the lowest is about 0°C. The range is about 30°C.**
4. Compare the climates in the two places. **The temperature range is greater in Semipalatinsk, where the winters are drier and more severe. Rainfall is higher in Monterrey, especially in the summer.**

Use the information below to answer the questions about climate in Pueblo, Colorado.

Rainfall: January 1 cm, February 2 cm, March 2.5 cm, April 4 cm, May 4 cm, June 3.5 cm, July 5 cm, August 4.5 cm, September 3 cm, October 2 cm, November 1 cm, December 1.5 cm
Temperature in degrees Celsius: January 0°, February 0°, March 5°, April 10°, May 15°, June 20°, July 24°, August 24°, September 18°, October 11°, November 5°, December 0°

5. When is the rainy season in Pueblo, Colorado? **It is in the summer.**
6. Compare the climate in Pueblo to the climate in Monterrey. **The climate in Pueblo is more severe with colder winters and drier summers.**

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Chapter 14

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Use with Section 3

• Climatic Changes

Climate and Extinction

About 65 million years ago, at the end of the Cretaceous period, dinosaurs became extinct. But they were not the only species to become extinct at that time. Up to 70 percent of all the species alive disappeared. Because so many different kinds of organisms died out, scientists do not think the cause was specific to dinosaurs, such as a disease. They think there was a general change in the environment. Climate, especially temperature, is an important influence on species' existence.

During the Age of Dinosaurs, from 240 million to 65 million years ago, Earth's climate was generally mild. Glaciers melted and ocean temperatures rose. Mountain ranges in North America and Europe eroded. A warm, shallow sea covered much of the interior of western and southern North America. A warm, shallow ocean flowed around Earth near the equator, and its currents warmed the land. The continents were closer together and nearer to the equator than they are now.

The climate of the continents began to change as they drifted apart. By the end of the Age of Dinosaurs, the level of the oceans began to drop and the seas drained away from the land. Temperatures in the ocean went down. Many species died out when the temperature fell. Almost all the reptiles that lived in the ocean died out at this time. So did 90 percent of the plankton, tiny floating organisms that make up an important source of food to many sea animals. Many shelled sea creatures disappeared as the shrinking ocean reduced their shallow-water habitat.

Large amounts of volcanic activity also took place in the Age of Dinosaurs. Volcanic ash and dust in the atmosphere from this activity may have lowered Earth's temperature by blocking sunlight. It may have also affected Earth's climate by changing the composition of the atmosphere. This change may have increased the amount of solar radiation the atmosphere absorbed. This could have heated the atmosphere, creating a thermal imbalance and unstable weather conditions. The resulting change in Earth's environment could have affected organisms living at that time.

1. What was the climate like during the Age of Dinosaurs? **It was generally mild and the waters of the oceans were warm.**

2. How did the climate change from the beginning of the Age of Dinosaurs to the end? **At the end of the Age of Dinosaurs, the climate got cooler and the warm, shallow seas began to drain away from the land.**

3. What are some factors that affected the climate during the Age of Dinosaurs? **volcanic activity, position of the continents, currents from warm ocean waters**

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Chapter 15

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Use with Section 1

• Cells: The Units of Life

Using the Microscope

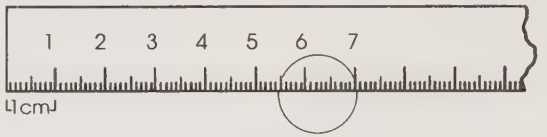
Use the information below to complete the table and answer the questions.

There are many different kinds of microscopes. A magnifying glass is a simple microscope. The term *microscope* commonly refers to a compound microscope. These microscopes are called compound because they are made of several glass lenses in a tube.

The total magnifying power of a microscope is the product of the magnifying power of the lens in the eyepiece and the magnifying power of the lens in the objective. Most compound microscopes can magnify a specimen up to 1000 times its real size.

Microscopes allow you to see fine details. Spaces between objects that are closer together than 0.1 mm can be seen. The ability of a microscope to separate very small distances is called resolving power. If the resolving power of the lens is not good, the image will appear blurred.

When you look into the eyepiece of a microscope, the circular area you see is the field of view. When a ruler is placed across the opening on the stage, the field of view can be measured in millimeters.



	Eyepiece lens	Objective lens		Total	
		Low	High	Low	High
Microscope 1	10×	5×	40×	**50×**	400×
Microscope 2	8×	10×	60×	**80×**	**480×**
Microscope 3	**5×**	10×	**60×**	50×	300×

1. What is the purpose of a microscope? **to make small objects appear larger so that they can be observed more easily**

2. How do you find the total magnifying power of a microscope? **multiply the magnifying powers of the eyepiece lens and the objective lens**

3. What would cause an image to appear blurred? **poor resolving power or dirt on lenses causes blurred images**

4. What is the width of the field of view shown above? In centimeters? **1.5** In millimeters? **15**

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Chapter 15

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Use with Section 2

• Cell Organization

Building a Cell

Make a three-dimensional model of a cell using the following guidelines.

Materials

glass cake pan or bowl
light-colored gelatin
various small items to make cell parts (may be food or nonfood items)

Procedure

1. Decide what items you will use to represent each of the cell parts listed below. Refer to the diagram of a cell in your textbook for ideas for the shapes and sizes of cell parts.
2. Prepare enough gelatin to fill your glass container about half to 3/4 full. Follow the instructions on the gelatin package.
3. When the gelatin becomes thick enough, add your cell part items to the gelatin.
4. Refrigerate your cell to finish setting.
5. Once you have built your cell, organize your information in the table below.

Data and Observations

Cell part	Item used	Function of actual cell part
cell membrane		controls movement of materials into and out of cell
nucleus		directs cell activities
chromatin	Answers will vary.	controls the makeup of the cell's cytoplasm and cell activities
endoplasmic reticulum		moves materials around inside the cell
ribosomes		make protein
mitochondria		supply the cell with energy
Golgi bodies		package and move proteins
vacuoles		store water, food, or waste products

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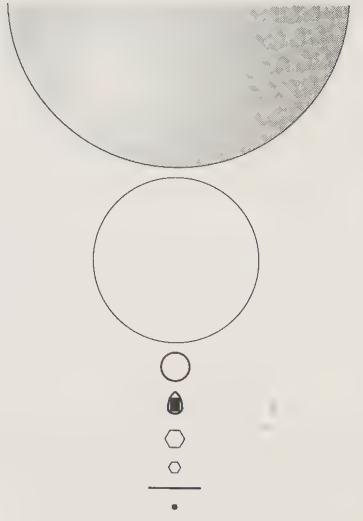
Use with Section 3

• Viruses

The Size of Viruses

Study the graph below. It shows the sizes of viruses, bacteria, and other structures. The largest is a red blood cell. The rest are important because they cause illness.

Cells	Largest Diameter (in μm)
Red blood cells	7500
Bacteria *Streptococcus*	750
Herpes simplex virus	130
Rabies virus	125
Flu virus	85
Polio virus	27
Virus that affects plants	15
Red blood cell molecule	15



After studying the graph, answer the following questions.

1. About how large is a red blood cell? about 7500 μm
2. How large are the smallest viruses that affect plants? 15 μm
3. What is the smallest thing shown on the graph? a red blood cell molecule
4. The smallest viruses attack what kinds of organisms? plants
5. How do the rabies virus and the polio virus compare in size? The rabies virus is much larger than the polio virus.
6. How large is the *Streptococcus* bacteria? 750 μm
7. How large are human red blood cells? about 7500 μm
 Red blood cell molecules? about 15 μm
8. In general, which are larger, viruses or bacteria? bacteria

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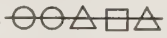
Use with Section 1

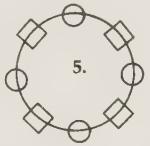
• What is classification?

Classifying Patterns

Small children classify things when they sort blocks into piles according to color, shape, or texture. Scientists have many ways of classifying both organisms and information.

In this exercise, you will classify 12 different patterns. As pictured, these are different shapes in varied orders on a "string." You could just as easily use a specific color of bead to represent each shape. This would make it easier to work with the groups. Pretend the beads or shapes are different patterns of genetic information on a chromosome and it is your job to devise a way of classifying these differences in a meaningful way.

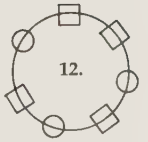
1. 
2. 
3. 
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8. 
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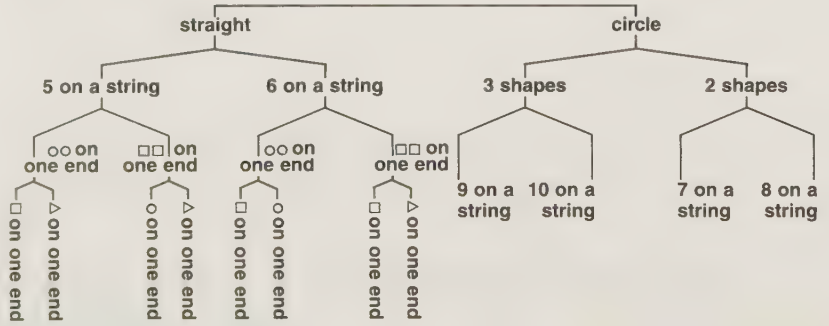
1. Can you divide these into two groups? yes What would each group have in common?

 either a linear or circular arrangement

2. Examine each group and find a way to divide each into two groups. What does each group now have in common? The linear arrangement has either 5 or 6 shapes in a row.

 The circular arrangement has either 2 or 3 different shapes.

3. Repeat these steps until you have separated all twelve patterns into different categories. Draw a "tree" that splits into two at each choice, and write a short description indicating what the choice is at each step.



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Use with Section 2

• Modern Classification

Animal Characteristics

Animals are many-celled organisms that must obtain food to stay alive. Most animals can move about in the environment. About 95 percent of the known species of animals do not have backbones or skeletons inside their bodies. In the animal kingdom, animals are classified into nine main groups called phyla.

Use reference books and your textbook to find information to complete the table below.

Animal Phyla Characteristics

Phylum	Common Name	Characteristics
Porifera	sponges	thick sac of cells with pores, canals, and chambers; live in water; attached to one place
Cnidaria	cnidarians (sea anemone, hydra, jellyfish)	central cavity and mouth; most have tentacles; live in water; float or attached to one place
Platyhelminthes	flatworms	flattened body; free-living in water or parasitic
Nematoda	roundworms	round body in cross section; free-living in water or on land; some are parasitic
Annelida	segmented worms	body divided into segments that have bristles; free-living in water or on land
Mollusca	mollusks (snails, octopus, squid, scallop)	soft bodies; most have shells or shell-like coverings; live in water or on land
Arthropoda	arthropods (insects, spiders, shrimp)	body divided into sections; jointed legs; have exoskeletons; live in water or on land
Echinodermata	echinoderms (sea cucumber, sea urchin, sea star)	spiny or leathery skin; radial symmetry; water-vascular system; live in salt water
Chordata	chordates (vertebrates)	internal skeleton; specialized body systems; paired appendages; live in water and on land

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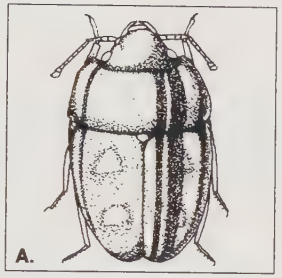
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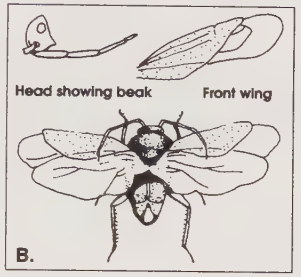
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• Identifying Organisms

A Bug or a Beetle?

Often we pick up an insect and casually refer to it as a bug or a beetle. Using scientific definitions, the insect may not belong to either of these orders of insects. Bugs belong to the order Hemiptera and beetles belong to the order Coleoptera. Look carefully at these two pictures and use the key below to find out which order these insects belong to. The key is not complete for all orders of insects, but it should help you tell the difference between bugs and beetles. There are a few wingless bugs that are not covered by this key. Use references if needed.





1. **Wing type**
 - **a.** Wings transparent. Go to step 2.
 - **b.** Front wings hard or leathery and covering hind wings. Go to step 2.
2. **Type of mouthparts**
 - **a.** Mouthparts chewing. Go to step 3.
 - **b.** No chewing mouthparts. Go to step 4.
3. **Wing venation**
 - **a.** Front wings with veins. Order: Orthoptera
 - **b.** Front wings without veins. Antennae usually 11 segments, often 8–10. Order: Coleoptera
4. **Front wing texture**
 - **a.** Front wings nearly always thickened at the base; membranous at tip; beak comes from front or bottom of head; antennae have 4 or 5 segments. Order: Hemiptera
 - **b.** Front wings of uniform texture; beak comes from hind part of head. Order: Homoptera

1. Which insect is a true bug and which is a true beetle? **Picture B is a bug, picture A is a beetle.**

2. What are some of the distinguishing characteristics of the insects shown? List them below.

	Bug	Beetle
Order:	**Hemiptera**	**Coleoptera**
Wings:	**transparent**	**have no veins**
Antennae:	**4–5 segments**	**11 segments**
Mouthparts:	**not chewing**	**chewing**

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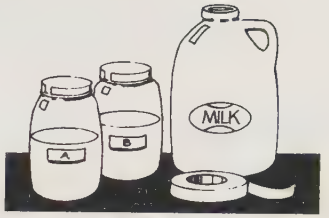
Use with Section 1

• Two Kingdoms of Bacteria

How Temperature Affects Bacterial Growth

Materials

2 same-size clean glass jars with lids
refrigerator
fresh milk
pen
masking tape



Procedure

1. Pour milk into each jar, filling each about half full. Screw the lid onto each jar.
2. On each jar place a piece of masking tape. With a pen, label one "A" and the other "B."
3. Place jar A in the refrigerator. Place jar B in a warm place. Observe the contents of the two jars over a seven-day period.

Data and Observations

	Appearance	
	Day 1	Day 7
Milk in jar A	**white liquid**	**may smell sour**
Milk in jar B	**white liquid**	**thick, lumpy, sour smell, color change**

Conclude and Apply

1. What could have caused the change in jar B? **the growth of bacteria**

2. Since the jars were sealed, what can you say about the presence of bacteria in the milk when you poured it into the jars? **Bacteria must have already been present in the milk.**

3. How did the temperature affect the growth of bacteria in the two jars? **the warmer the temperature, the faster the growth of bacteria**

4. From this experiment, what would you infer was the primary purpose of a refrigerator? **to slow the growth of bacteria**

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Chapter 17

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Use with Section 2

• Bacteria in Your Life

Expiration Dates

Have you ever noticed the expiration dates marked on the foods you buy at the grocery store? These dates are marked by the manufacturer of the product to inform you of the last date the store can sell the food. After that date, within a few days to weeks, depending on the type of food, the population of bacteria in the food will make the food unsafe to eat.

Procedure

Look in your cupboard and refrigerator at home and find the expiration dates on six foods. Record what you have found in the table below. Then answer the questions that follow.

Data and Observations

Food	Expiration date	Location of date	Description of container
		Answers will vary.	

Conclude and Apply

1. Where was the date usually found? on the top or bottom of the food container
2. Shelf life is how long a food can be stored and is still safe to use. Which food had the shortest shelf life? Most students will probably find that milk has the shortest shelf life.
3. Which food had the longest shelf life? Answers will vary, but may include canned goods or crackers.
4. In what kind of container was the food with the longest shelf life? Most students will find canned food has the longest shelf life.
5. Why do you think this product has a long shelf life? Answers will vary. Canning food prevents bacteria from growing. Other foods may be dehydrated or may contain preservatives.

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NAME DATE CLASS

Chapter 18

ENRICHMENT

Use with Section 1

• Kingdom Protista

Protists in a Jar

Materials



grass or hay that has not been chemically treated
pond water
glass jar with top
magnifying lens

Procedure

1. Put a handful of grass or hay into the jar.
2. Fill the jar about half full with pond water.
3. Place the top on the jar, but do not screw it on. Then put the jar in a dark place for three or four days.
4. After three or four days, observe the contents of the jar. Use your magnifying lens to study the contents.

Data and Observations

1. What can you see with your magnifying lens? Describe any protists you observe. Most students will be able to see some tiny protozoans or algae.
2. Do any of the protists appear to be moving? probably
3. Draw the protists you observe in the space below.

Conclude and Apply

1. What structures do protists have that allow them to move from place to place? cilia, flagella, and pseudopods
2. Why might some of the protists look green? They contain chlorophyll and are photosynthetic.

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Chapter 18

ENRICHMENT

Use with Section 2

• Kingdom Fungi

What makes dough rise?

Materials

1 cup flour
1 tablespoon of sugar
1 package of dried baker's yeast
measuring cup
glass jar
marker
clock
warm tap water
spoon



Procedure

1. Put the flour and sugar into the glass jar.
2. Put 1/4 cup warm tap water into the measuring cup. Add the package of yeast, stirring with a spoon.
3. Slowly stir the yeast water into the flour and sugar mixture. Stir until dough forms. Push the dough down to the bottom of the jar. Mark the height of the dough on the outside of the jar.
4. Put the jar in a warm place. You could put it by a heat outlet or place the jar in a pan of warm water.
5. Watch the clock. Every ten minutes, mark the height of the dough on the outside of the jar. Continue this for an hour.

Conclude and Apply

1. What happened to the dough during the hour? **The dough increased in size, rising in the jar.**
2. What kind of fungus is the yeast you added? **sac fungi**
3. What does yeast use for energy? **sugar**
4. What did you add that acted as food for the yeast? **1 tablespoon of sugar**
5. What are the waste products when yeast consumes food? **alcohol and carbon dioxide**
6. After an hour, could you see any bubbles in the dough? **yes**
7. What gas could you conclude caused these bubbles? **carbon dioxide**
8. What made the dough rise? **The consumption of the sugar by the yeast produced carbon dioxide, which made the dough rise.**

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Chapter 19

ENRICHMENT

Use with Section 1

• Characteristics of Plants

Sweet Celery

The following activity will show you how a vascular plant moves nutrients to all its parts.

Materials

2 fresh, washed stalks of celery with leaves (stalks from the middle of the bunch work best)
2 tall glasses
sugar
measuring spoons
masking tape
pen



Procedure

1. Fill each glass half full with water.
2. Add 4 tablespoons of sugar to one of the glasses. Label the glass "sweet" on a piece of masking tape.
3. Label the other glass "water."
4. Put a celery stalk in each glass and leave them for 48 hours.
5. Taste the leaves from each stalk. **CAUTION:** *Never taste anything in a lab setting. This activity is safe because it uses only celery, sugar, and water.*

Data and Observations

1. How did the celery leaf from the sugar water taste? **sweet**
2. How did the celery leaf from the plain water taste? **not sweet; like a plain celery leaf**

Conclude and Apply

1. How did the sugar get from the water to the celery leaf? **The sugar dissolved in the water and moved through vascular tubes to the leaf.**
2. How do plants get nutrients from the soil to their leaves? **Nutrients in the soil dissolve in water and move through the vascular tubes to the leaves.**
3. What advantages do plants with this adaptation have? **These plants could grow tall and still get nutrients to their leaves.**

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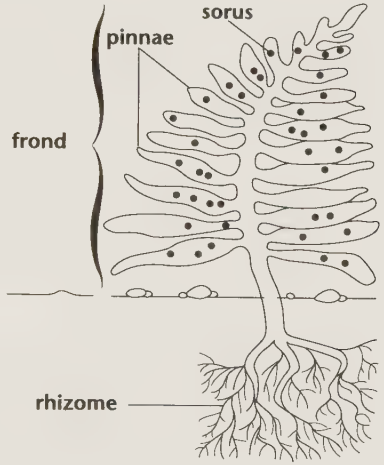
Use with Section 2

• Seedless Plants

Ferns

The fossil record shows that ferns first appeared almost 400 million years ago. There are many fern species living today. Most of these 1200 fern species live in the tropics, although some live in temperate and arid regions. Ferns vary in size from tiny, mosslike species to giant treelike forms. One treelike form found on Norfolk Island in the South Pacific can reach a height of almost 30 meters. The structure of the fern leaf, or frond, is well adapted to the filtered light of forests. The fronds are widely spaced and divided into leaflets, called pinnae, which are angled to catch the light. The spores of the fern are clustered together in the sori.

Draw a fern and label the parts. Include the terms frond, pinnae, sorus and rhizome.



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Use with Section 3

• Seed Plants

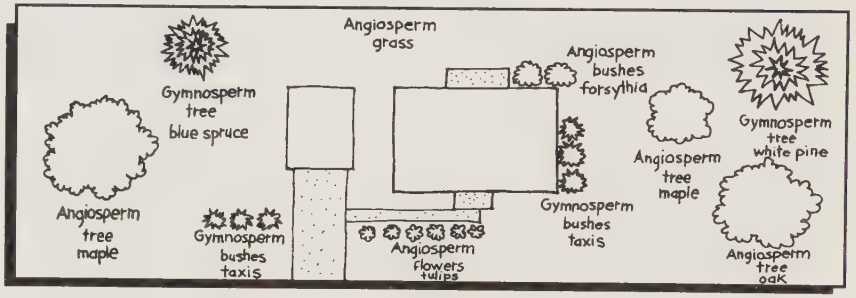
Mapping Gymnosperms and Angiosperms

Materials

paper
pencil

Procedure

Choose an area with which you are familiar—a yard or a small park or the school grounds. Using a blank sheet of paper, make a map of the area that shows the major plants and identifies them as either gymnosperms or angiosperms. Make your map similar to the one below.



Identify the plants you map as specifically as you can. As shown on the example map, first write "Angiosperm" or "Gymnosperm." You may use information in your textbook to help you identify the plants as one or the other. Then, write a general term such as "tree," "bush," "flower," or "grass." Finally, write the specific name for any plants that you know. Ask adults for help. Many adults will be glad to tell you the names of the bushes and trees they have planted in their yards. Also, you can find books on tree and bush identification in almost any library.

Conclude and Apply

1. Did you find more angiosperms or gymnosperms? **Answers will vary.**

2. Of the angiosperms you identified, which are monocots and which are dicots? **Answers will vary.**

3. What can you conclude about the variety of plants in an area? **Most students will say there is a wide variety of plants in an area.**

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Chapter 20
ENRICHMENT

Use with Section 1

• What is an animal?

Looking at Animal Characteristics

Your textbook names five characteristics that all animals have in common. Prove to yourself that together, these characteristics define only animals. First, briefly write a description of each characteristic. Then, fill in the table of living things by writing yes or no in each box, depending on whether that living thing has that characteristic.

Characteristic 1: **cannot make their own food**

Characteristic 2: **digest their food**

Characteristic 3: **most move from place to place**

Characteristic 4: **have many cells**

Characteristic 5: **cells are eukaryotic**

When completing the table below, you may look at other chapters in your textbook or consult an encyclopedia.

	Characteristics				
Living thing	1	2	3	4	5
kelp	no	no	no	yes	yes
bacterium	yes	yes	yes	no	no
bird	yes	yes	yes	yes	yes
dog	yes	yes	yes	yes	yes
fern	no	no	no	yes	yes
fish	yes	yes	yes	yes	yes
flatworm	yes	yes	yes	yes	yes
insect	yes	yes	yes	yes	yes
jellyfish	yes	yes	yes	yes	yes
lobster	yes	yes	yes	yes	yes
mushroom	yes	yes	no	yes	yes
parameclum	yes	yes	yes	no	yes
snail	yes	yes	yes	yes	yes
tree	no	no	no	yes	yes

Which organisms are animals? **bird, dog, fish, flatworm, insect, jellyfish, lobster, and snail**

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Chapter 20
ENRICHMENT

Use with Section 2

• Sponges, Cnidarians, Flatworms, and Roundworms

Planarian Regeneration

Materials

- large wide-mouth jar
- hand lens
- pond water
- spring water at room temperature
- cooked egg yolks or raw meat
- magnifying glass
- art knife



Procedure

1. Planarians can be found near the shoreline of ponds that have decaying leaves and other debris. Fill your wide-mouth jar with this shoreline material and a few inches of pond water.
2. Let the jar sit overnight. In the morning, planarians will likely be clinging to the sides of the jar. Planarians look like small, dark, jelly-like blobs. Remove much of the shoreline material, and add some more pond water.
3. Using the magnifying glass and art knife, carefully cut two planarians in half as shown above. **CAUTION:** *The art knife is very sharp. Be careful when using sharp objects.* Return cut planarians to the jar.
4. Once a day, feed the planarians some egg yolk or raw meat. After about an hour, remove the remaining egg yolk or meat, drain as much of the water away as possible, and replace with fresh pond water or bottled spring water.
5. Observe the planarian parts for a week and then return them to a pond.

Data and Observations

What do your planarian parts look like after a week? **Answers will vary, although most planarian parts will have regenerated into whole planarians.**

Conclude and Apply

1. Why did the planarian parts change? **Answers may vary. Some students may answer that the planarian parts died because of inadequate food or water temperature or because cutting the worms in half killed them. Some may answer that planarians can regenerate damaged or lost parts.**
2. How would regeneration affect the planarian population? Explain your answer.

Regeneration increases the planarian population. Planarians don't die when cut in half, but grow into two worms. When planarians are injured, instead of losing a member of the population, regeneration adds a new member to the population.

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Use with Section 3

• Mollusks and Segmented Worms

Snail Behavior

As you know from your textbook, snails are a type of mollusk in the class known as gastropods. Snails like damp, dark environments and can be found under leaves and near rotting logs. When searching for snails, go to a natural area in a park or woodlot. Use gloves when picking up snails. Handle them gently.

Materials

- old aquarium or clear wide-mouthed jar
- glass top for aquarium or jar lid with holes
- fresh lettuce
- snails



Procedure

1. Search for snails near a rotting log. Turn over moist logs, boards, or leaves.
2. Place the snails into an aquarium or jar along with woodland materials. Punch holes in the top of the jar for air, or place a glass top over the aquarium leaving a small opening for air.
3. Feed the snails fresh lettuce every day.
4. Observe the snails eating.
5. Watch for snail activity during daytime hours and during nighttime hours.
6. For one 24-hour period, place the jar or aquarium into a dark closet during the day and shine a strong light onto the environment during the night. Observe the snails' activity.

Observations

1. How fast does a snail move? **Answers will vary, although the emphasis will be on the slowness of their movement.**
2. How long does it take a snail to eat a leaf of lettuce? **Answers will vary. One snail will probably take hours to eat a leaf of lettuce.**
3. Were the snails more active during the day or night? **Snails are more active at night.**
4. What happened when you changed the pattern of light? **Most students will observe that the snail was more active during the artificial darkness of the closet than when the light was shined on the jar.**
5. From your observations, would you conclude that snails in their natural environment are more active at night or during the day?
 at night

When your observations are completed, return the snails to their natural environments.

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Chapter 20
ENRICHMENT

Use with Section 4

• Arthropods and Echinoderms

Crickets

A common arthropod of the insect class is the cricket, a small bug with antennae, wings, and powerful hind legs. The word *cricket* comes from a French word meaning "to click or creak." Anyone who has had a cricket in the house has observed their noise-making abilities. Crickets can easily be found from spring through fall in fields and vacant lots. They can also be purchased at bait stores that sell fishing supplies or pet stores.

Materials

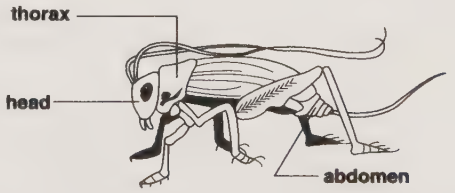
- wide-mouthed clear glass jar
- rubber band
- old nylon stocking
- scissors
- thermometer
- clock with second hand
- crickets

Procedure

1. Catch a cricket in a field or buy one from a pet or bait store.
2. Place the cricket in the jar. Cut a top for the jar from the old nylon stocking. Secure the cover with the rubber band.
3. Observe the cricket's body parts and make a sketch of the arthropod. Label your sketch with these terms: head, thorax, abdomen.
4. Wait until the cricket is chirping regularly. While watching the second hand of the clock, count how many chirps the cricket makes in 15 seconds. Add 40 to the number of chirps you counted. Compare that sum to the temperature of the room.
5. Move the jar to a warmer place (near a sunny window, for example). Make your count again.

Observations

Draw your sketch here.



Conclude and Apply

1. How did the sum of the number of chirps compare with the temperature reading?
 Answers will vary, but the numbers should be close.
2. What happened to the number of chirps when you moved the jar to a warmer place?
 The number increased.
3. How does temperature affect cricket activity? **Crickets become more active with a rise in temperature.**

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NAME DATE CLASS

Chapter 21

ENRICHMENT

Use with Section 1

• Fish

Chordate Hearts

The hearts of fish, amphibians, and reptiles are all different. This is because each type of animal has different needs and different body functions.

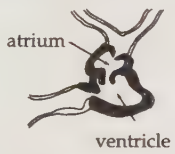
Fish have hearts with only two chambers, an atrium and a ventricle. Their blood flows in a simple path from the heart to the gills, where it is oxygenated, to body tissues, and back to the heart. This two-chambered heart supports the life of the fish because fish don't need as high a level of energy for body functions as land vertebrates. Fish are supported and buoyed up by the water they live in.

Amphibians and reptiles have a more complex circulatory system than fish. This better enables them to deal with the environmental problems of living on land. Amphibians and reptiles have a third heart chamber that helps the heart to keep oxygenated and deoxygenated blood separate.

Amphibians carry on respiration through their skin as well as lungs. Unlike fish, they have two atria instead of one. One atrium receives oxygenated blood from the lungs, and the other receives deoxygenated blood from body tissues. Both atria empty into a single ventricle. The ventricle lets blood bypass the lungs when the animal is under water.

Reptiles don't have skin respiration. Reptile hearts have two atria and a ventricle. But unlike the amphibian's, the reptile heart has a partially divided ventricle. This wall further decreases the mixing of oxygenated and deoxygenated blood and allows oxygenated blood to be pumped continually to the body.

Decide if the following are hearts of fish, amphibians, or reptiles. Label the diagrams, then answer the questions that follow in complete sentences.



fish



amphibian



reptile

1. Summarize how the number of chambers in the hearts of fish, amphibians, and reptiles relates to their lifestyles. **The more energy an organism requires, the more complex the heart. Generally, land-living organisms require more energy.**

2. Why do you think humans and birds have a more advanced type of heart than fish, amphibians, and reptiles? **Answers may vary, but might include that warm-blooded animals such as humans and birds lead a far more active life. Their hearts have four chambers to meet higher oxygen needs. The mammal heart efficiently prevents mixing of oxygenated and deoxygenated blood.**

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Chapter 21

ENRICHMENT

Use with Section 2

• Amphibians and Reptiles

Designing an Experiment

Amphibians hibernate during the cold winter months, burying themselves in mud or leaves until the temperature rises. They don't eat and they barely move during hibernation. Their bodies slow down. Do you think that their internal body processes also slow down? One internal process that you can observe in a frog is its breathing, because you can watch the movements of a frog's throat as it breathes in air. To find out how temperature affects breathing, you could count the frog's breaths and relate them to temperature.

With those thoughts in mind, design an experiment that would examine the effect of changes in temperature on amphibian body processes. Use the materials listed below in your experiment design. You can add other materials if you wish. Write the step-by-step procedure of how you would perform your experiment. Then, write a statement of what you would expect the results of the experiment to be. Remember, you don't want to harm the amphibian in any way.

Materials

- frog or other amphibian
- thermometer
- glass jar
- ice
- warm water
- pan
- clock or watch



Students' designs will vary, but in general they should chart the number of breaths a frog takes at a certain temperature over a certain amount of time. Observations could be made with the frog in the jar with the thermometer and the ice or warm water in the pan. The general statement should be something such as "the number of breaths a frog takes decreases with a decrease in temperature."

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Chapter 21

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Use with Section 3

• Birds

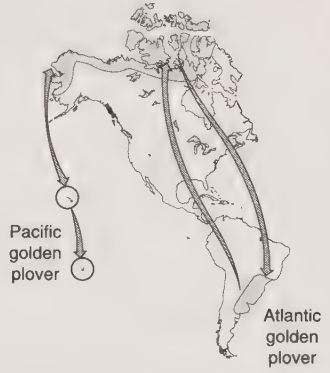
Migration of Birds

Many animals, particularly birds, have a remarkable ability to migrate over thousands of miles of land and sea. Yet we know very little about how they do this. Clearly these animals must have special mechanisms of navigation and orientation.

The Atlantic golden plover flies over 8000 miles from the northernmost part of Canada, its arctic breeding ground, to an area of the southeastern part of South America. Perhaps it is even more extraordinary that the Pacific golden plover finds its way from the Western region of Alaska to the Hawaiian and Marquesas islands—relatively small pieces of land in the vast Pacific Ocean.

After much research, scientists have determined that these birds migrate by the sun and stars. Some species of birds cannot migrate successfully in cloudy weather. However, many other species continue to migrate under clouds and through fog. This posed another problem for scientists.

After many experiments, it was confirmed that by combining information from two sources, birds can point themselves in a particular compass direction. These sources are the sun or constellation of stars, and their "internal clocks," which are related in some way to 24-hour periods. But even this does not explain birds' ability to migrate on a cloudy day or starless night.



There is much experimental evidence that birds can detect Earth's magnetic field and orient themselves with it. Very little is known about how birds detect magnetism. However, bits of magnetite, a magnetic iron ore, have been found in the heads of pigeons. It is assumed at present that the magnetite is involved in some way in the pigeon's "magnetic sense." Indeed, scientists have upset a pigeon's flight pattern by attaching a small magnet to the bird.

Much has been learned about navigation and orientation of birds and other animals. Yet scientists are far from understanding how birds can migrate with such accuracy for great distances year after year.

Question and Observations

1. Until fairly recently how were birds thought to orient themselves on a long, migratory flight?
They used the sun to navigate by day and constellations of stars by night. They seem to have been aided by their "internal clocks."

2. What recent discovery helps to explain how birds can fly in a particular compass direction?
Bits of magnetite have been found in the heads of pigeons. These are presumed to be involved in the birds' "magnetic sense" or sense of compass direction.

3. How does a homing (messenger) pigeon find its way from the coast of France to its cage on the roof of a London apartment house? **It uses several cues: the sun or stars, its "internal clock," and its "magnetic sense."**

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Chapter 21

ENRICHMENT

Use with Section 4

• Mammals

Observations of a Mammal

You will observe characteristics of a mammal in the following activity.

Procedure

Choose a family pet or some pet you know well in the neighborhood. Make sure the pet is a mammal. Pets might include a dog, a cat, a rabbit, a gerbil, a horse, or a mouse. Observe the mammal, keeping in mind the characteristics that you learned about in your textbook. Add to your observations by looking in an encyclopedia or some other reference book that might include information about your mammal. Complete the table below with your observations and the information you gained by reading about this mammal.

Data and Observations

Characteristic	Observation/Information
Animal type	**Answers will vary depending on mammal observed.**
Scientific classification (kingdom, class, order)	
Outer covering	
Teeth	
Food	
Reproduction (type, mammal classification, gestation period)	
Other characteristics	

Conclude and Apply

1. After observing the mammal's teeth and food choices, would you classify it as an herbivore, a carnivore, or an omnivore? **Answers will vary depending on mammal observed.**

2. What characteristics of the mammal you observed seem to make it well suited to living in your home or neighborhood? **Answers will vary.**

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Chapter 22

ENRICHMENT

Use with Section 1

• Types of Behavior

Animal Behavior Research

The Austrian scientist Konrad Lorenz and the Dutch zoologist Niko Tinbergen were the founders of an approach to behavior called ethology. These two men shared the 1973 Nobel Prize in medicine and physiology with the German biologist Karl von Frisch. **Ethology** is the study of animal behavior in nature, and is concerned with innate behavior patterns. Instincts and reflexes are innate behaviors.

Learned behavior is acquired as the result of experience. There are several kinds of learned behavior. **Habituation** is a form of learning in which an animal learns not to respond to a stimulus. Animals may learn not to respond to stimuli that are repeated frequently and that are unimportant to them. Conditioning is another type of learned behavior. There are two kinds of conditioning. Ivan Pavlov, a Russian psychologist, knew that dogs respond to the smell of food by salivating. This response is innate. Pavlov wanted to know if the salivation response could be caused by a less likely stimulus. Pavlov rang a bell at the same time the dog was given food. Eventually, the sound of the bell was enough to cause the dog to salivate. This type of conditioning is known as **classical conditioning.**

The American psychologist B.F. Skinner used pigeons to study another type of conditioning. He realized that if a certain behavior were followed by a reinforcement or reward, the behavior was more likely to be repeated in the future. To study this phenomenon, he invented the Skinner box. The box contained a typewriter-like key connected to a food supply. If the pigeon pecked at the key, it would be rewarded with food. This type of learning is called **operant conditioning.** If the response is reinforced with a reward, the behavior tends to be repeated.

Determine if the following behaviors are innate or learned. If the behavior is innate, determine if the behavior is an instinct or a reflex. If the behavior is learned, determine if the behavior is habituation, classical conditioning, or operant conditioning.

1. The first time a squirrel sees a nut, it tries to bury it.	innate	instinct
2. Jane touches a hot curling iron and jerks her hand away.	innate	reflex
3. John is startled by a loud noise outside his window. The same noise is repeated several times, but John no longer responds.	learned	habituation
4. Cindy is teaching her dog tricks. When the dog rolls over at her command, she rewards it with praise.	learned	operant conditioning
5. A planarian moves away from bright light. It curls up when electrically shocked. When a bright light is closely followed by an electric shock, the planarian curls up. Eventually, the light alone causes the planarian to curl.	learned	classical conditioning
6. Kittens stalk imaginary prey.	innate	instinct

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NAME DATE CLASS

Chapter 22

ENRICHMENT

Use with Section 2

• Behavioral Adaptations

Adaptations for Night Living

Many animals sleep during the day and become active at night. These animals are nocturnal. When we think of all the things an animal must do to survive, it is apparent that night living requires some special sensory adaptations. An owl has such good hearing that it can pick up the smallest sounds of a rodent stepping over dry leaves or twigs 23 meters away!

Procedure

Use the library to find out more about nocturnal animals such as the owl. Fill in the table below with information gathered from your library research.

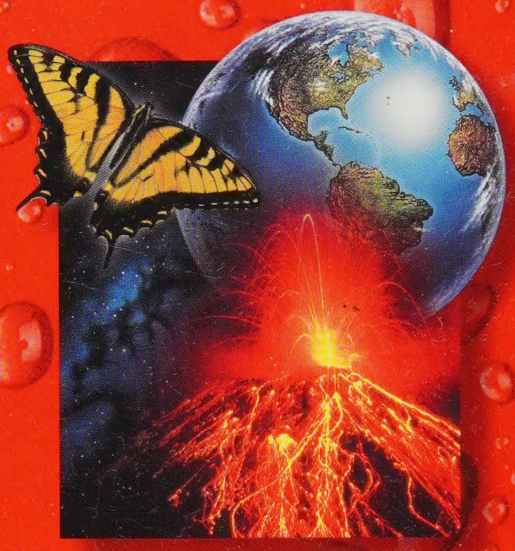
Data and Observations

Sensory Adaptations for the Owl	
Vision	**The eyes of an owl are positioned to look straight ahead. Because the owl sees an object with both eyes, it can focus in a wider range.**
Position of eyes:	
Size of eyes:	**An owl's eyes are quite large. Because of their size, they can catch most of the available light.**
Hearing	**Instead of small holes in the skull, the holes are huge, allowing more sound to enter.**
Size of ear openings:	
Directing sound into ear openings:	**The owl has two facial discs around each eye that funnel the sound into the ear openings.**
Other adaptations for hunting and foraging at night:	**The feathers have a soft edge. This results in noiseless flight. The owl hunts by listening and watching while flying very close to the ground. It can hear better and fly close to its prey without being heard.**

Conclude and Apply

1. What is another animal you have read about that is nocturnal? **Answers will vary, but may include bats, raccoons, or opossums.**
2. What adaptations does it have for night living? **Answers will vary.**

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